Iron AND Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

1010 EMPIRE BLDG. JANUARY - 1942 JAN 30 1942 PITTSBURGH, PA.

TECHNOLOGY

The USN Ordnance Flag and Navy "E" Pennant have been awarded Mesta Machine Company for Excellence in Production

Mesta 6,000 ton Hydraulically Operated Forging Press Forging a 100" Ingot in the Mesta Forge Shop

MESTA MACHINE COMPANY PITTSBURGH, PA.

UNITROL

HOW TO PACK More Production into Less Space!

Whether you are building, or just cramming more motorized machines into your present quarters, let Unitrol cut down the space required for each machine and save you more space than has hitherto been possible.

For this important advance in Motor Control housing, pioneered by Cutler-Hammer, enables you to put two or three times as many starters in the space required by conventional starter mounting methods. Unitrol "cleans up" the space around machines, permitting them to be crowded closer together. And Unitrol offers so many other advantages . . . in design, construction, range, flexibility and adaptability . . . in space, time, money and building economies . . . that manufacturers in every type of industry are rapidly swinging over to Unitrol.

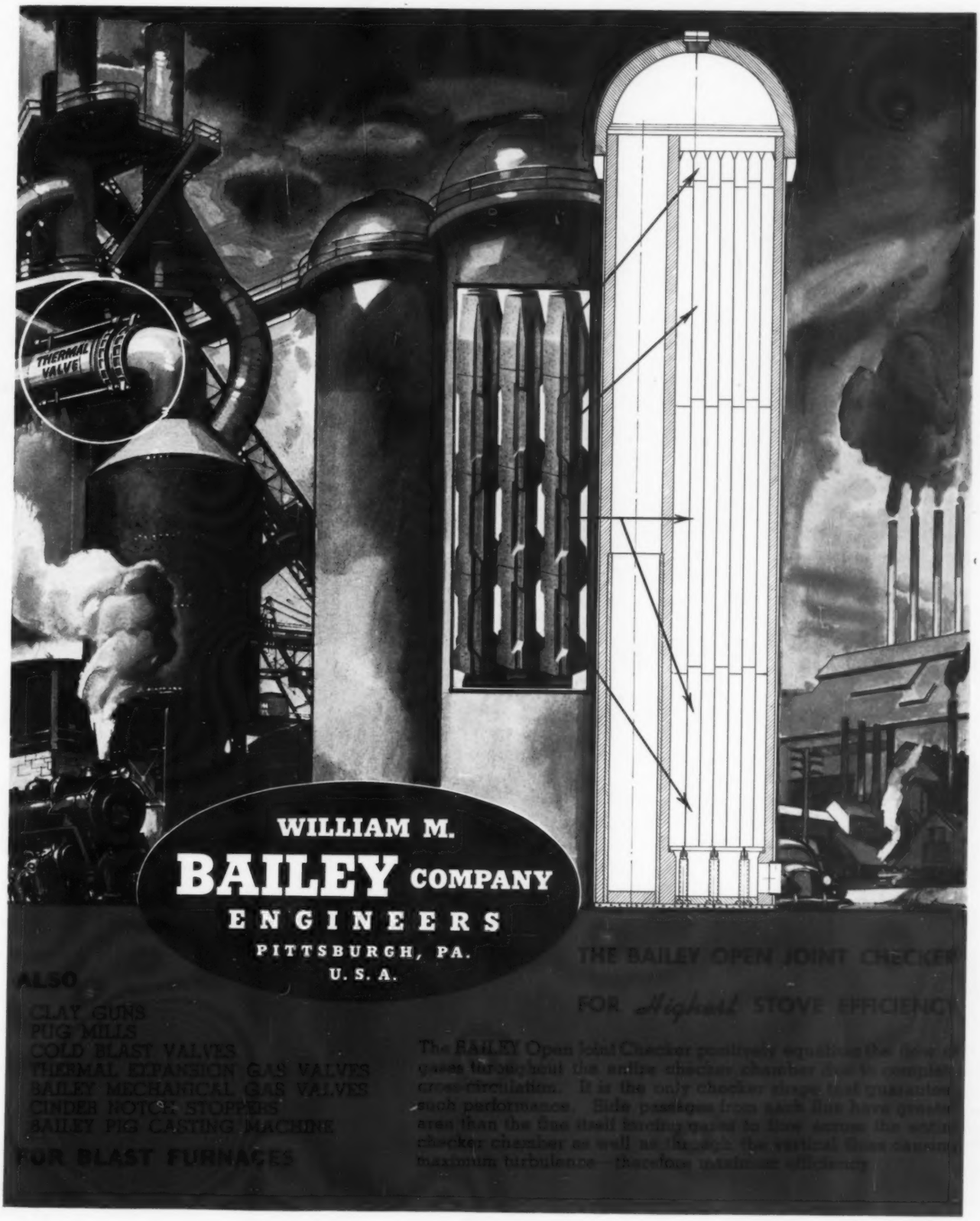
If you haven't read the book "UNITROL . . . the next step forward in Motor Control Practice", you should do so at once. A copy will be sent you free, without obligation. Simply dictate a letter to your secretary at once, before you forget. CUTLER-HAMMER, Inc., 1269 St. Paul Avenue, Milwaukee, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto.

Copyright, 1941—Cutler-Hammer, Inc.

CUTLER-HAMMER
UNITROL
C-H

1892-1942 50th ANNIVERSARY

LEADERSHIP THROUGH QUALITY


THERMAL VALVE
WILLIAM M.
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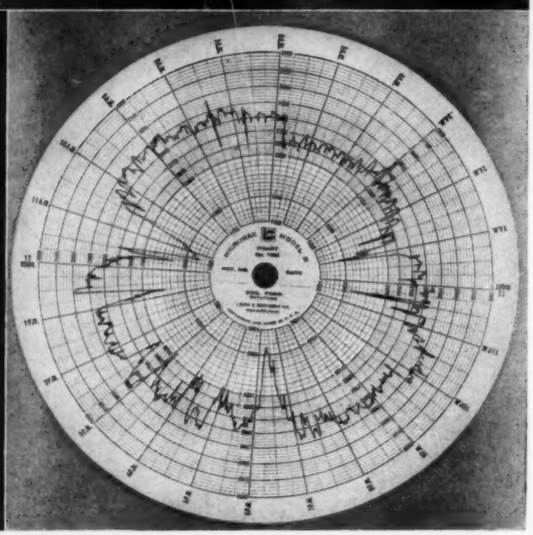
COLD BLAST VALVES
THERMAL EXPANSION GAS VALVES
BAILEY MECHANICAL GAS VALVES
CINDER NOTCH STOPPERS
BAILEY PIG CASTING MACHINE
FOR BLAST FURNACES
THE BAILEY OPEN JOINT CHECKER
FOR Highest STOVE EFFICIENCY
The BAILEY Open Joint Checker positively equalizes the flow of
gases throughout the entire checker chamber due to complete
cross-circulation. It is the only checker design that guarantees
such performance. Side passages from each flue have greater
area than the flue itself forcing gases to flow across the entire
checker chamber as well as through the vertical flues causing
maximum turbulence—therefore maximum efficiency.



Top: Mounted outside the furnace, Rayotube watches temperature of furnace roof.
Left: The Number One Helpers can read open-hearth temperature easily on the big dial of this Micromax Recorder.
Right: Typical record of one day's operation.

FIRST HELPERS "ELECT" MICROMAX TO WORK IN O-H SHOP

Given a chance to use Micromax pyrometers in their shop, the First Helpers of Empire Sheet & Tin Plate Co. at Mansfield, Ohio, have turned in their verdict. They like the Micromax. They use it constantly; it helps them hold a heat more even, and make it in less time. They can see, when they come on shift, exactly where the heat stands and what has happened to it. Micromax substitutes fact for guesswork; enables the men to do a better job.

The equipment is simple and fool-proof. A Rayotube is mounted well above the bath level at the back of the furnace, so that it points at the roof through a hole in the furnace wall. It is connected, like a thermocouple, to a Micromax Recorder, and lasts indefinitely.

The equipment can, if desired, be used also for automatic control and many such installations have been made. If you're interested in either recording or controlling, ask for Bulletin N-33B-600B.

Heat-Treater lowering the cover of Raymond Mfg. Division's Homo tempering furnace. Springs are brought to heat quickly and uniformly by Homo's forced-convection heating.

Spring Maker Prefers Homo Method for Accurate, Uniform Spring-Temper

Tempering of springs is an art which has been practiced by the Raymond Mfg. Co., Division of Associated Spring Corp., Corry, Pa., for 50-odd years, but the one tempering method preferred today in this plant is the Homo Method.

For, when a spring gets to the Homo, it will automatically receive the treatment which the heat-treater's experience and skill tell him it should have. He sets the temperature dial, and a time-signal too, if he wishes; then he can forget the batch until the signal calls him to unload the furnace. His time and skill are freed for other duties—"stretched" to help meet today's multiplied demands.

The Homo requires practically no attention; it runs almost continuously, taking work in any order, and jumping from one temperature to another at a turn of the hand. It has never yet produced a Raymond spring which was rejected for temper, but its automatically-made record of time and temperature is always available and is a valuable operating record.

On the Homo Method Controller's chart is a permanent record of time and temperature of drawing for each batch tempered.

Homo Method equipment is made in sizes and capacities for practically any parts-tempering need, and is so widely used that we can probably arrange for any interested person to inspect a comparatively nearby installation. So, if you have a parts-tempering problem, get in touch with us. If you'd prefer a catalog, just ask for No. T-625, "Homo Tempering."

PLEASE CLIP

DO US THE UNUSUAL FAVOR of checking the blanks below. Then mail us this coupon; you needn't sign your name. Thank you.

Did you read this adv. partly? ..... or entirely? .....

Would you rather have more facts about L&N equipment, and fewer about its use? .....

Does your plant use L&N Instruments? ..... or L&N Furnaces? .....

Leeds & Northrup Co., 4942 Stenton Ave., Phila., Pa.

LEEDS & NORTHRUP COMPANY, 4942 STENTON AVE., PHILA., PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

Jrl. Ad. ENT-0600C(36)

Keeping your batteries FULL OF... "GO"

TODAY—under the pressure of defense production, the ease with which Exide-Ironclad Batteries are maintained is a great relief to maintenance men in all lines of industry. Exide-Ironclads require only the simplest of care:

1 Add water once a week—and with the automatic water filler this job requires but a few minutes.

2 Hosing them down occasionally keeps batteries clean.

3 With automatic modern charging methods, practically no attention is required during the charge, and every charge is a full charge.

This simple maintenance keeps trucks equipped with Exide-Ironclad Batteries full of GO—all the time.

Exide IRONCLAD BATTERIES

THE ELECTRIC STORAGE BATTERY CO., Philadelphia
The World's Largest Manufacturers of Storage Batteries for Every Purpose
Exide Batteries of Canada, Limited, Toronto

and so...

The Bride Wore *Black*

YES, FOR MANY YEARS, the thrill of a train trip to Niagara Falls or anywhere else for that matter, had its dark side. Railroad passengers could either open the windows and risk a shower of dirt and cinders—or close the windows and endure a hot, stuffy trip.

And, unfortunately, most people assumed that nothing could be done about it. Sturtevant engineers, however, went to work on this problem—developed and built the pioneer railway air conditioning system. For the first time clean, cool air was available for railway passengers at the turn of a switch.

That was in 1910—years ahead of its time. With the growth of public interest in air conditioned theatres and restaurants, however, attention was turned again to the opportunities for air conditioned trains. Sturtevant had the answer.

Today, the vision of those men who foresaw the time when air conditioning would revolutionize railway travel has been realized. More than 8,500 cars on 40 railroads are equipped with Sturtevant Air Conditioning Systems or Apparatus.

And in countless other ways, Sturtevant "Puts Air to Work" for American and Cana-

Sturtevant

Puts Air to Work

for the Railroads

Broadway Limited—
Pennsylvania Railroad's 16 hour, New York to Chicago flyer features such travel luxuries as Barber and Maid Service, Bedrooms, Duplex Rooms—and complete Air Conditioning with Sturtevant Equipment.

Rocket—
One of 15 streamliners of Chicago, Rock Island and Pacific Railroad serving the Middle West and incorporating every known improvement in rail travel—including Air Conditioning by Sturtevant.

dian Railways . . . ventilating Tunnels, heating draft-swept Round Houses, cooling Diesel Engines and Traction Motors, fanning the flames of Power House Boilers.

B. F. STURTEVANT COMPANY

Hyde Park, Boston, Mass. *Branches in 40 Cities*

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Sturtevant

REG. U. S. PAT. OFF

Puts Air to Work

STURTEVANT — FOUNDER OF THE AIR HANDLING INDUSTRY

20th Century—

The most famous train in New York Central's crack New York to Chicago fleet, provides the utmost in safety, speed —and comfort provided by Sturtevant Air Conditioning Equipment.

Silver Meteor—

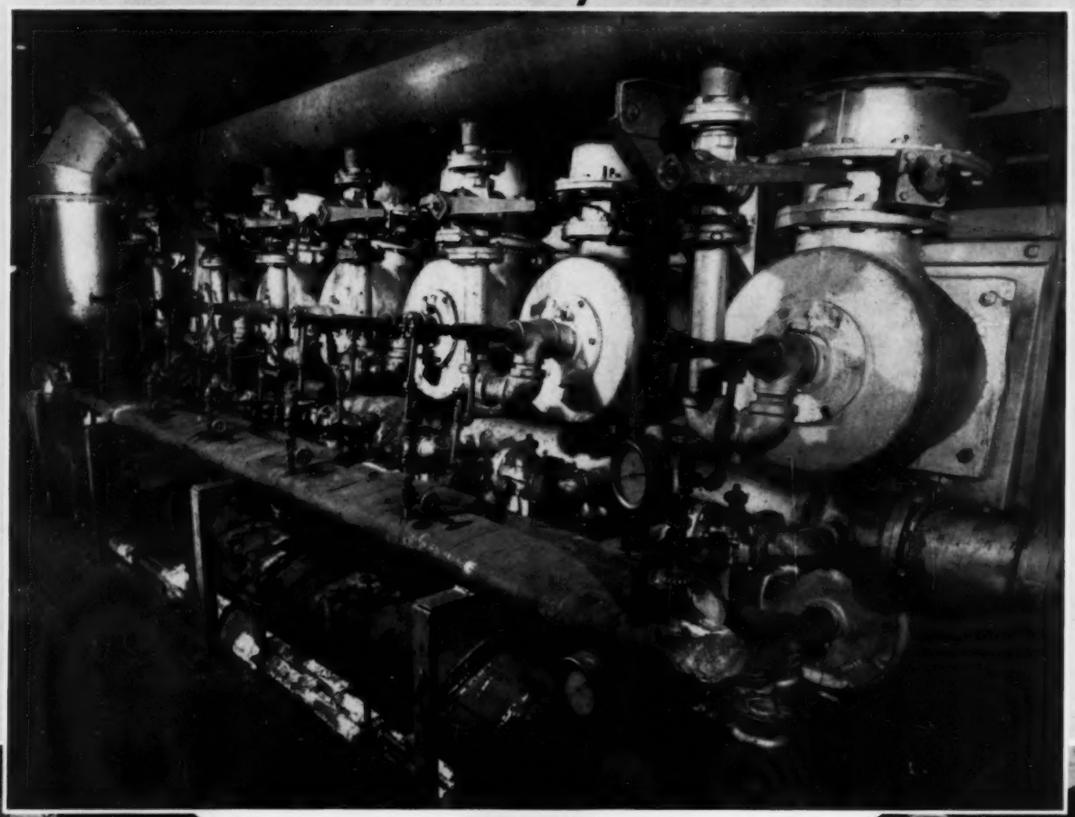
and the Orange Blossom, diesel-powered streamliners cut more than two hours from New York to Florida run of the Seaboard Railway—assure a cool, comfortable trip, with Air Conditioning by Sturtevant.

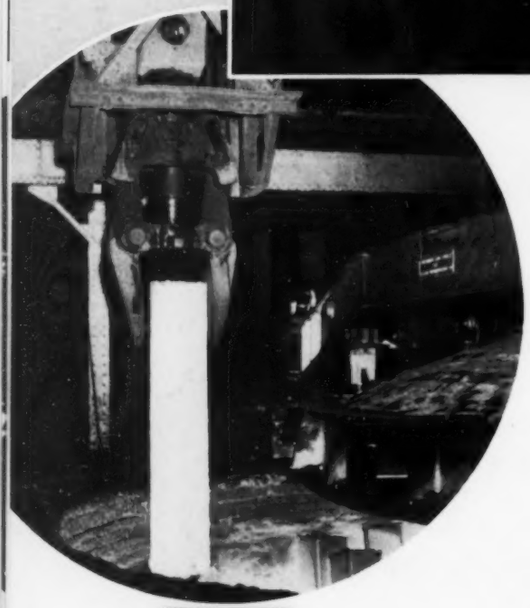
Crusader—

Reading Railway's new Philadelphia to New York Streamliner provides every up-to-the-minute comfort, at coach fares . . . including complete Air Conditioning with Sturtevant Equipment.

QUALITY SPEED ECONOM

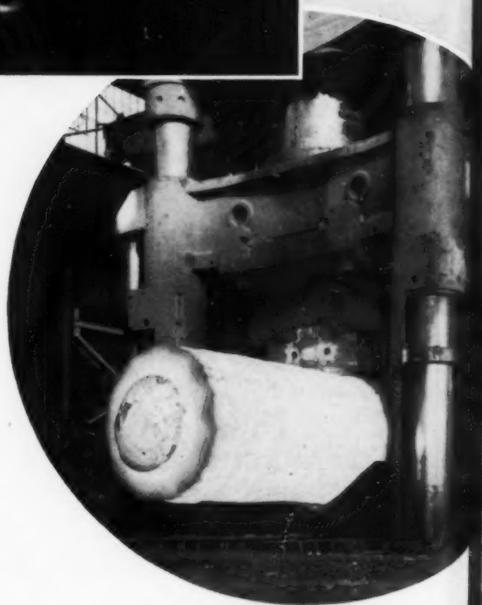
with **BLOOM** *long Flame burners*





IN BILLET HEATING FURNACES

With preheated or cold air. Top and bottom fired furnaces heating 185 lb. per sq. ft. per hr. Single zone fired furnaces heating 140 lb. per sq. ft. per hr.



IN SOAKING PITS

Burners now operating on every type of direct-fired or recuperative soaking pit. Cold steel heated with 1,200,000 Btu per net ton.

IN FORGING FURNACES

Quality heating of gun forgings, shells, bombs, etc. From 100 in. diameter ingots down to 3 in. shell stock.

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Why not look into the future

WITH SALEM

SALEM Equipment is Not Built just for the duration but is sturdily constructed to give years of service and is readily adaptable to commercial production.

SALEM ENGINEERING CO. SALEM, OHIO

SALEM ENGINEERING COMPANY

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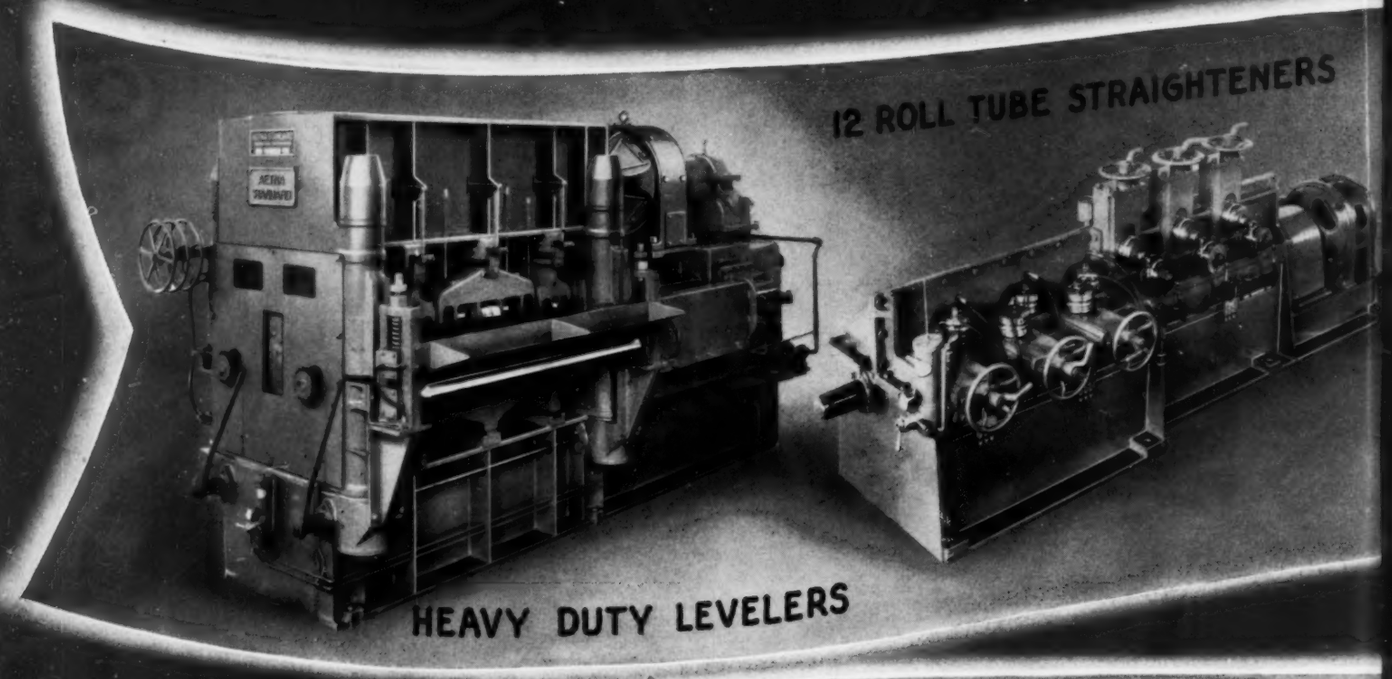
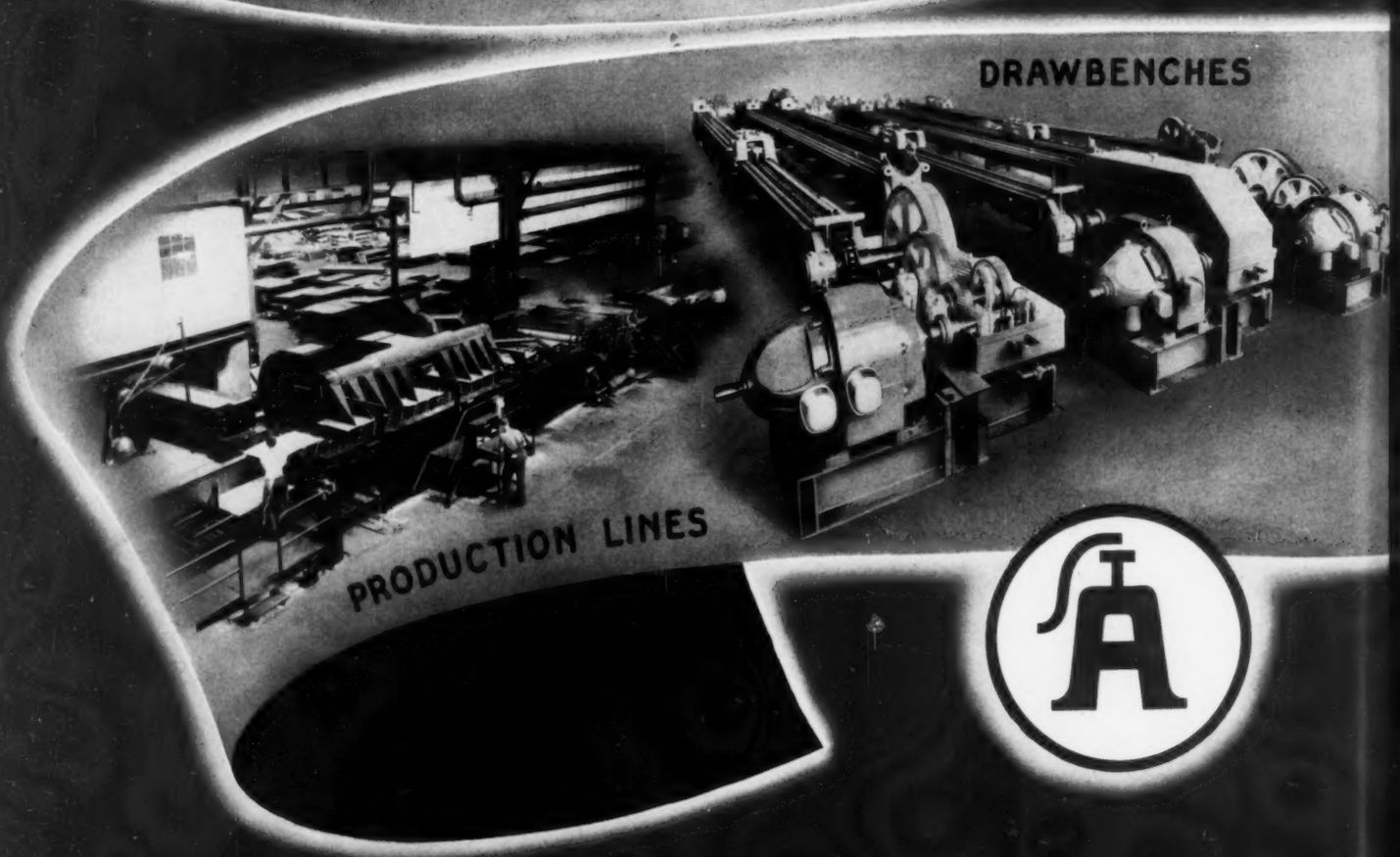
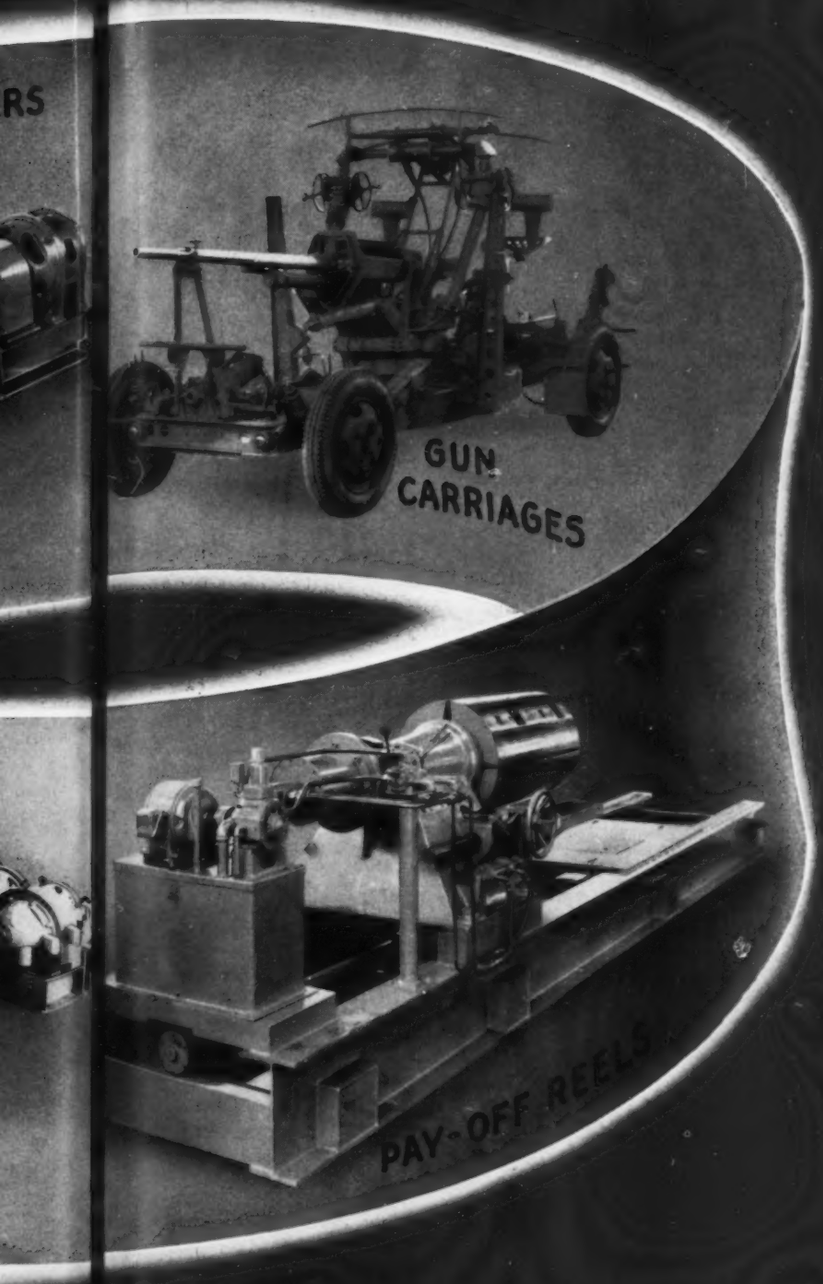




Designers and Builders to the Steel, No

T AN IDEAL



AETNA'S TWO GREAT PLANTS ARE WORKING NIGHT AND DAY TO PRODUCE THE MACHINERY SO ESSENTIAL TO PROTECT THE RIGHTS OF DEMOCRACY . . . AND WHEN WE ARE AGAIN AT PEACE, THIS SAME MACHINERY, INTELLIGENTLY DESIGNED AND SOUNDLY BUILT, WILL DO ITS PART IN REBUILDING A WAR-TORN WORLD

The AETNA-STANDARD ENGINEERING COMPANY
★ YOUNGSTOWN, OHIO, U.S.A. ★

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THORNABY-ON-TEES, ENGLAND

AKTIEBOLAGET ARBOGA MEKANISKA VERKSTAD
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JOHN INGLIS COMPANY, LIMITED
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el, Non-ferrous and Chemical Industries

EQUIPMENT *for* OFFENSE *by the*

WEAN

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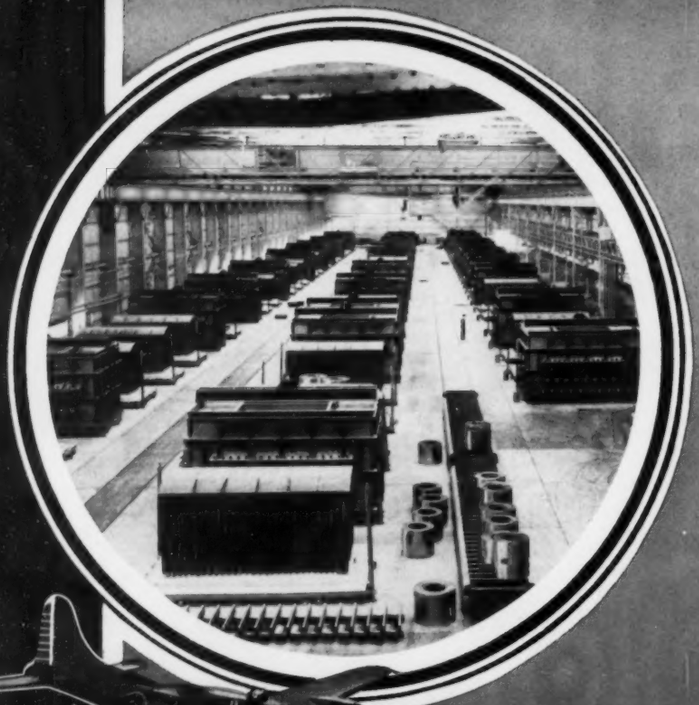
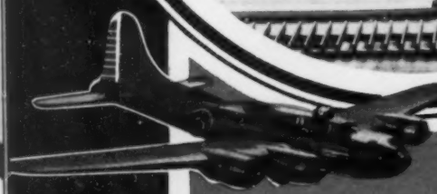
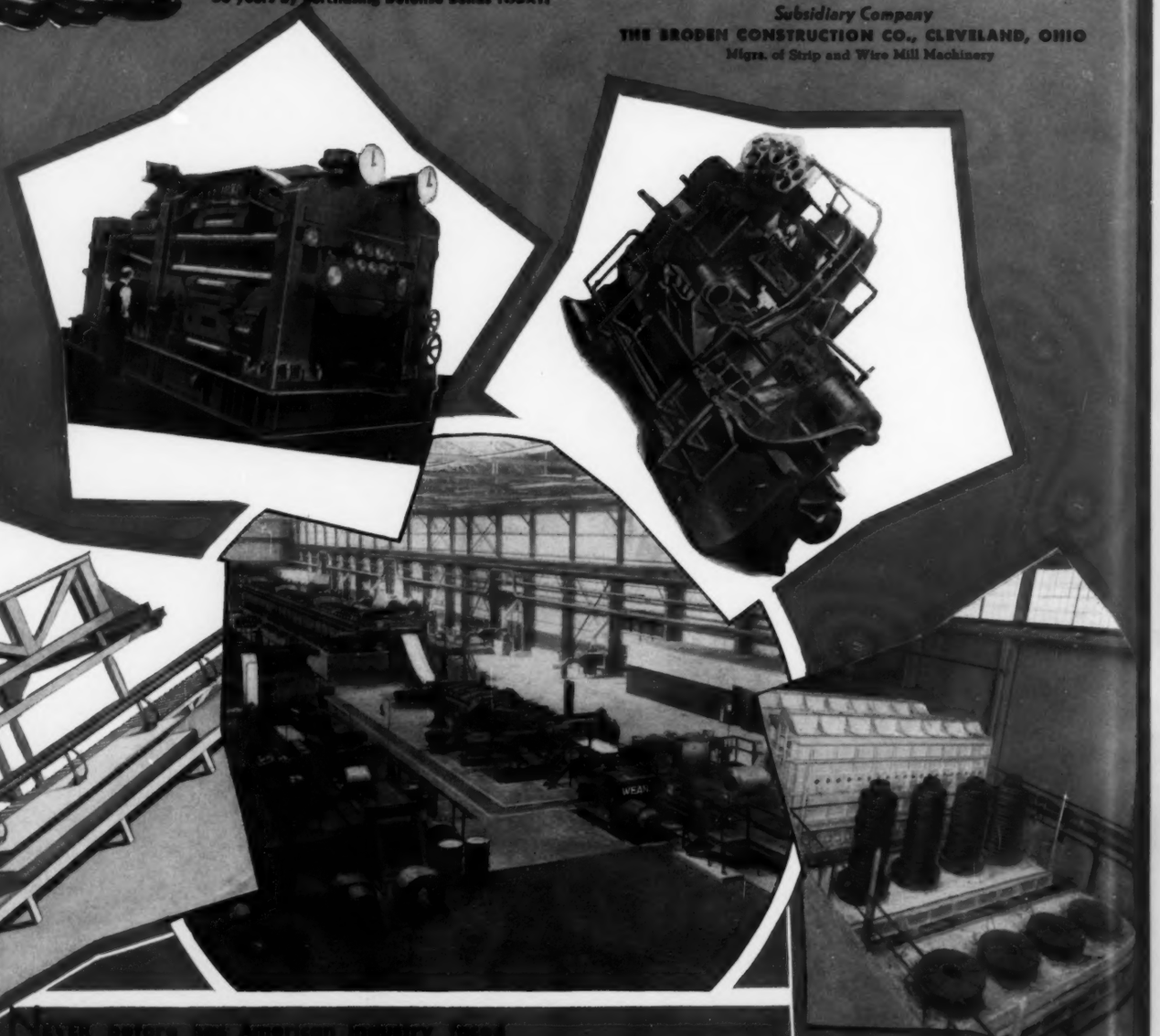
THE BRODEN CONSTRUCTION CO., CLEVELAND, OHIO

Mfgrs. of Strip and Wire Mill Machinery





The soldiers are doing their part.
Do yours by purchasing Defense Bonds TODAY!



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NEVER before has American industry faced such a challenge—such tremendous production schedules in so short a time!

Wean equipment is being engineered, produced and delivered in record time to manufacturers of defense materials.

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MADE IN U.S.A.
AMERICA'S NEWEST
4 HIGH REVERSING HOT MILL-27½-53½-112"
10 SKF BACK UP ROLL NECK MOUNTINGS
31" X 48" X 33"
16 SKF WORK ROLL NECK MOUNTINGS
4 HIGH NON REVERSING COLD MILL-24½-53½-112"
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31" X 48" X 33"
16 SKF WORK ROLL NECK MOUNTINGS
3 STAND TANDEM 4 HIGH COLD MILL-20"-49"-66"
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28" X 42" X 25¾
34 SKF WORK ROLL NECK MOUNTINGS
DURALUMIN ROLLING MILL

FOR DEFENSE

On the biggest jobs in Industry today, SKF Spherical Roller Bearings are providing BUILT-IN ALIGNMENT to compensate for shaft deflections, distortions and weave. HIGH CAPACITY and LOW FRICTION keep the wheels of Defense machinery turning at top speed.

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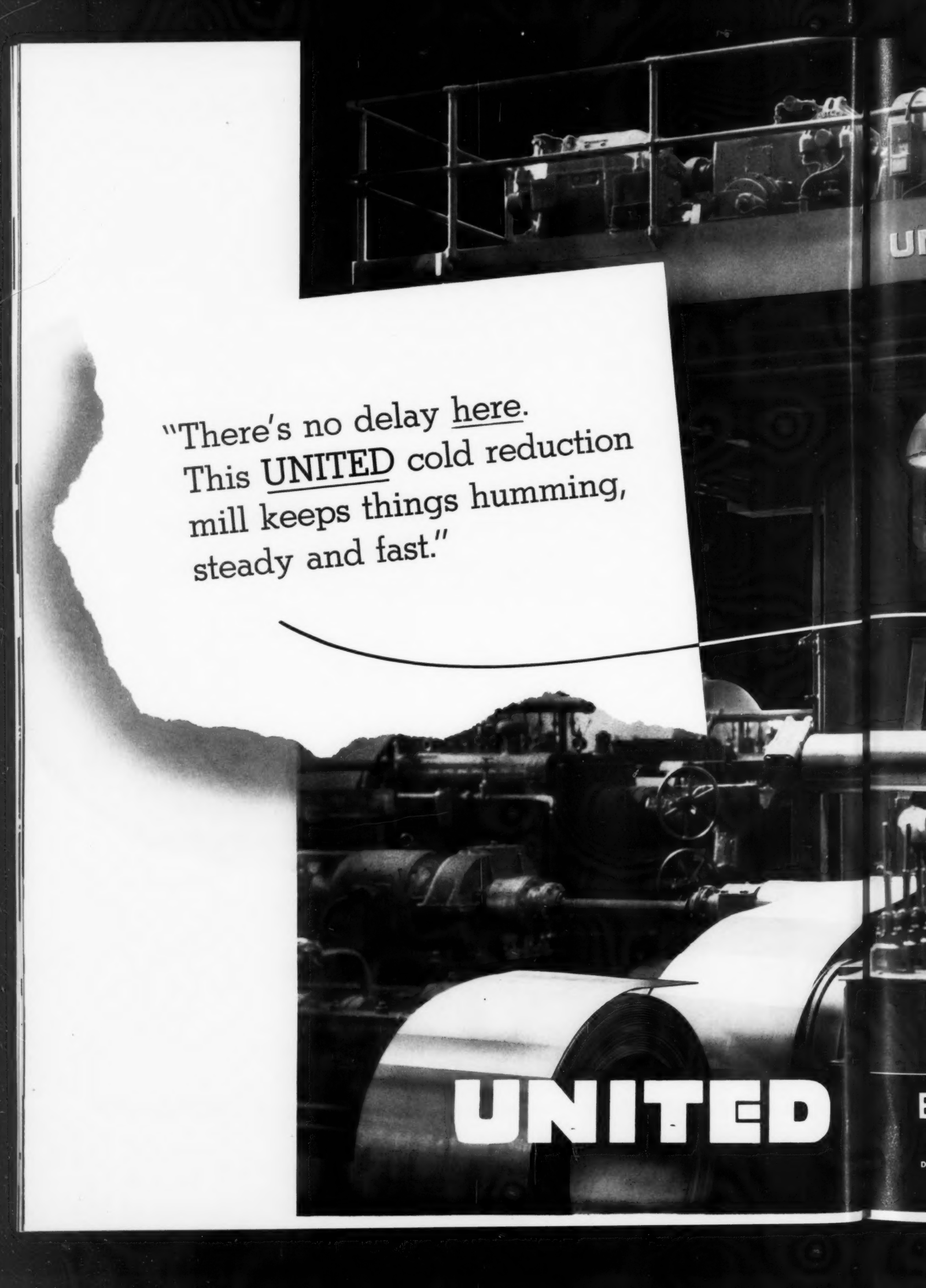
SKF

ROLLER BEARINGS


"There's no delay here.
This UNITED cold reduction
mill keeps things humming,
steady and fast."
UNITED

ENGINEERING *and* FOUNDRY COMPANY

Pittsburgh, Pennsylvania

DAVY AND UNITED ENGINEERING COMPANY, LTD., SHEFFIELD, ENGLAND · DOMINION ENGINEERING WORKS, LTD., MONTREAL, P. Q. · UNITED INTERNATIONAL, S. A. PARIS, FRANCE

Painting a "Cushion" on Open Gears

THE "CORRECT" ANSWER TO AN IMPORTANT PROBLEM IN VITAL DEFENSE PRODUCTION

Problem: The open gears at the right must be protected by a lubricant against wear due to: (1) Heavy or shock loads, (2) Dust and dirt in the air, (3) Presence of water.

The *correct* lubricant for this job must provide: (1) A tough film to prevent metal-to-metal contact, (2) A thin film to prevent accumulation of abrasives and packing of clearances, (3) A tough "waterproof" coating.

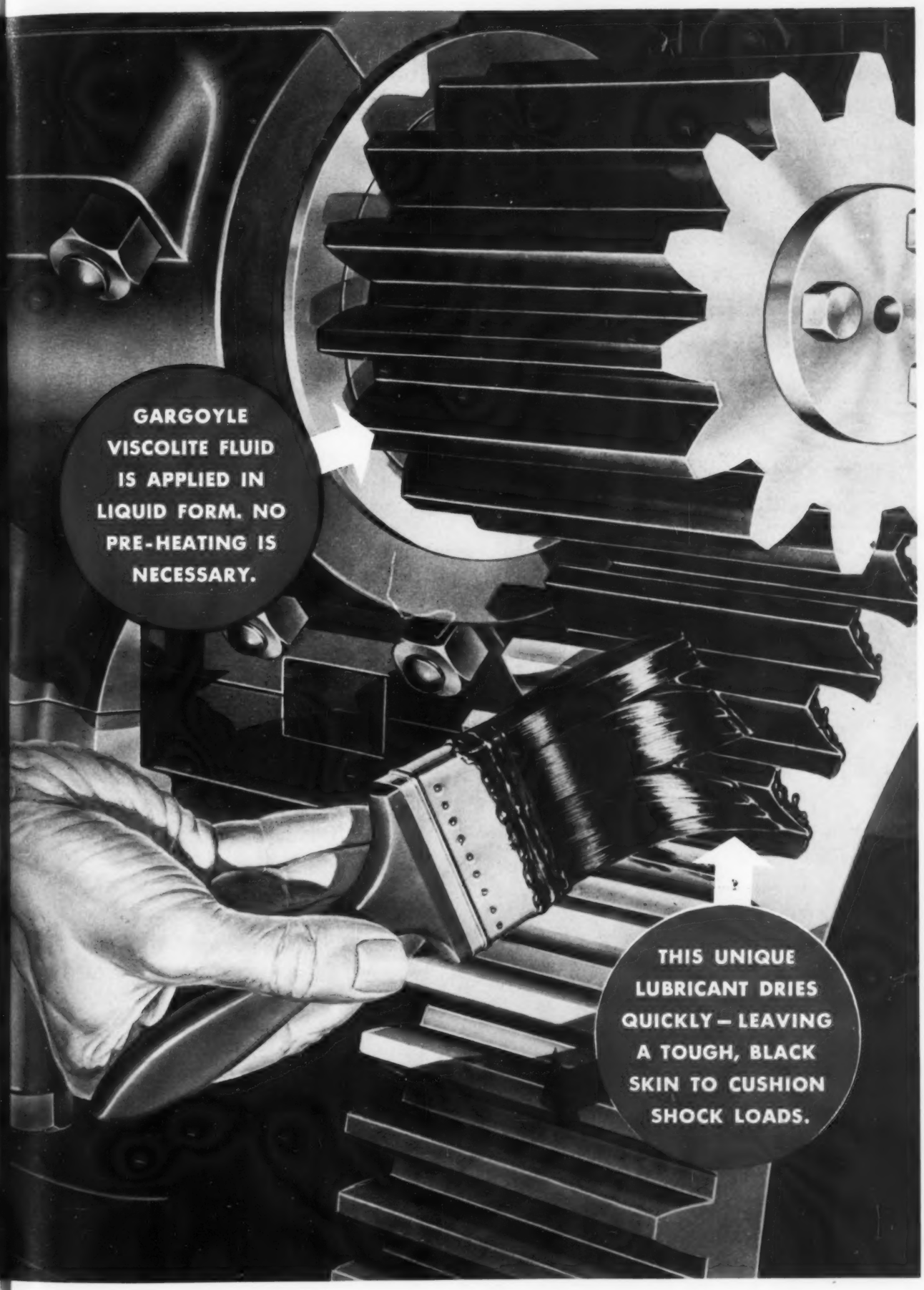
Answer: We have created a unique lubricant for this job — *Gargoyle Viscolite Fluid.* It can be applied by hand without heating, or be fed by mechanical devices. It is made with a quick-drying, non-inflammable diluent. As the diluent evaporates, a tough, black, thin skin is formed. *This film won't squeeze out or throw off!* As the film is thin, there is no opportunity to hold or pack dirt and dust. The tough coating sheds water like a duck. In many cases, Gargoyle Viscolite Fluid has helped reduce consumption more than 50%. This lubricant is available in four viscosities to fit every set of operating conditions.

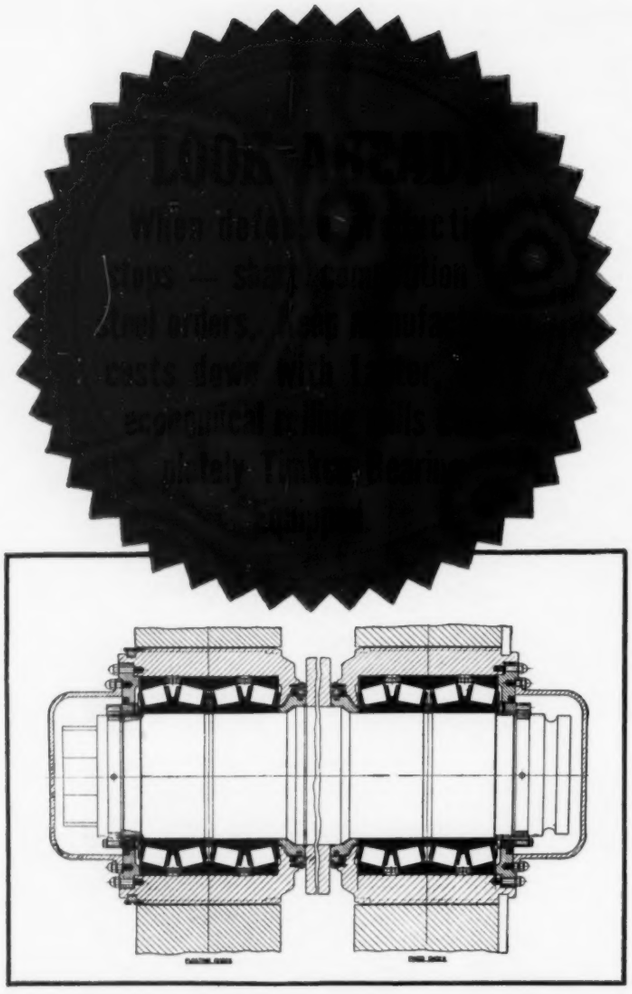
TO HELP MAINTAIN CAPACITY PRODUCTION, CALL IN

SOCONY-VACUUM for "Correct Lubrication"

GARGOYLE Lubricants

SOCONY-VACUUM OIL CO., INC. — Standard Oil of N. Y. Div. — White Star Div. Lubrite Div. — Chicago Div. — White Eagle Div. — Wadhams Div. — Southeastern Div. (Baltimore) — Magnolia Petroleum Company — General Petroleum Corporation of Calif.


GARGOYLE VISCOLITE FLUID IS APPLIED IN LIQUID FORM. NO PRE-HEATING IS NECESSARY.
THIS UNIQUE LUBRICANT DRIES QUICKLY – LEAVING A TOUGH, BLACK SKIN TO CUSHION SHOCK LOADS.

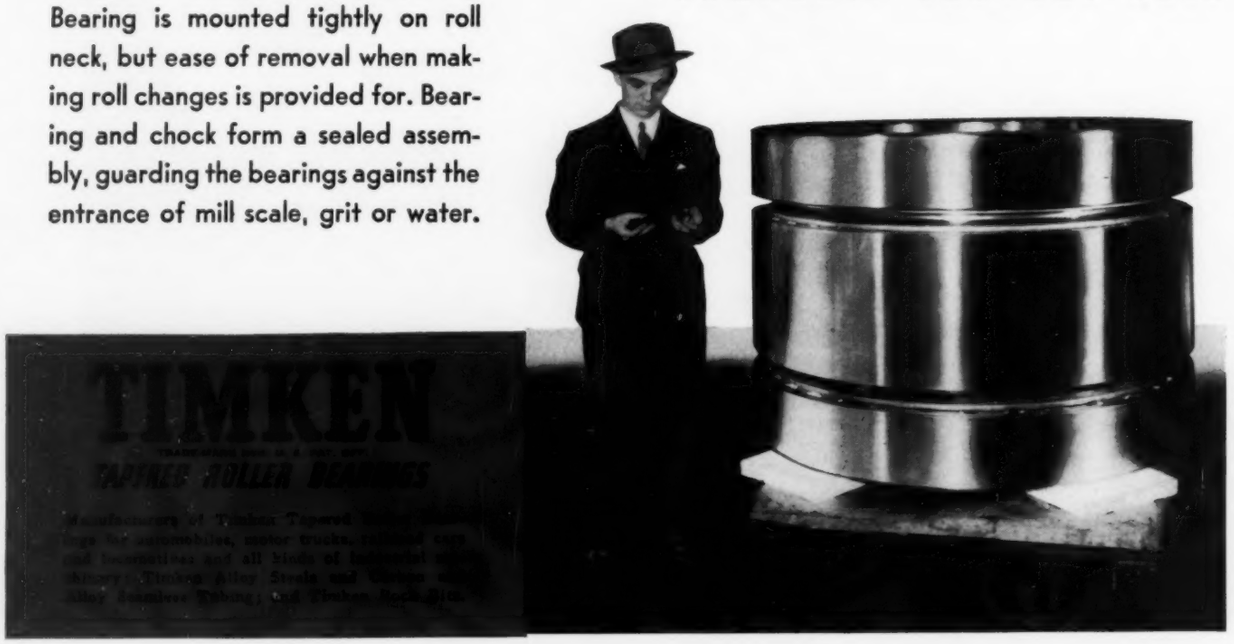


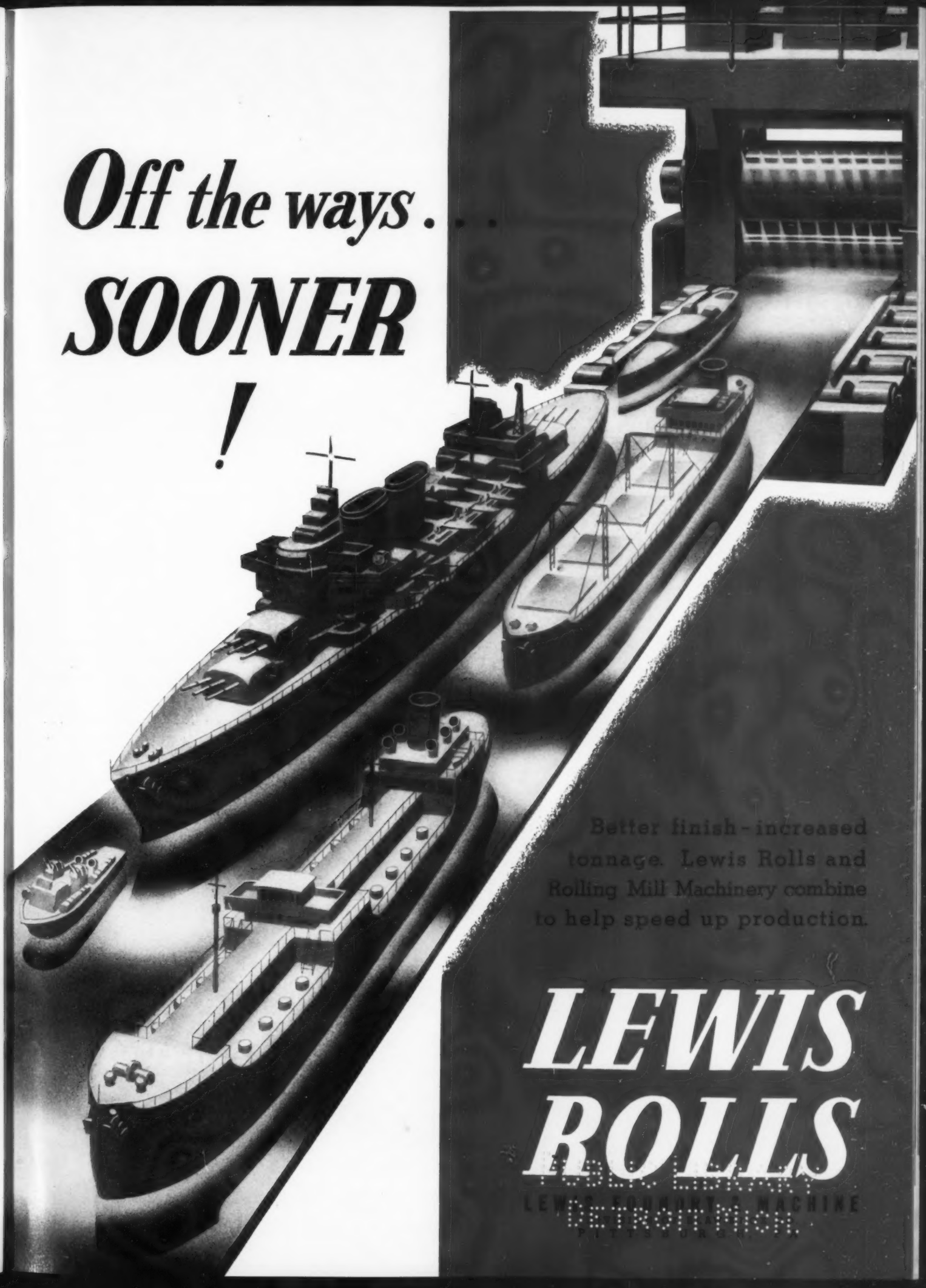
Timken Back-up Roll Neck Bearing as applied to a high-speed strip mill. Bearing is mounted tightly on roll neck, but ease of removal when making roll changes is provided for. Bearing and chock form a sealed assembly, guarding the bearings against the entrance of mill scale, grit or water.

Rolling mills equipped with Timken Roll Neck Bearings are doing a splendid job for defense, rolling ferrous and non-ferrous metals. The huge bearing shown below is one of a number of Timken Back-up Roll Bearings supplied to the Aluminum Company of America for its new 2,400-foot long rolling mill at Alcoa, Tennessee. These bearings measure 35½" bore x 51" outside diameter x 36" width, weigh 9,070 lbs. and have a mill separating force of 8,300,000 lbs. at mill speed.

The more Timken Bearings there are in rolling mills—on back-up rolls, work rolls and auxiliary equipment—the faster they operate; the more accurate they are; and the less they cost for operation and maintenance. These are the kind of mills that will meet the needs of the future.

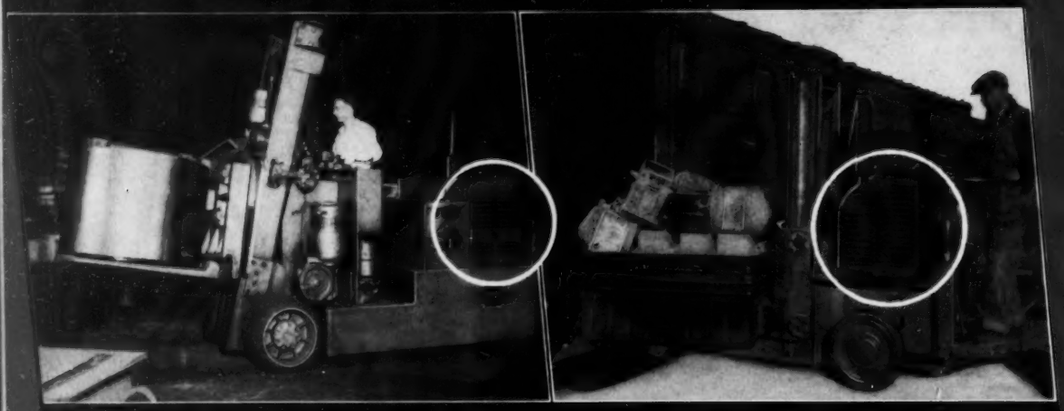
THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO




Off the ways . . .
SOONER
!
Better finish - increased tonnage. Lewis Rolls and Rolling Mill Machinery combine to help speed up production.
LEWIS ROLLS
LEWIS FOUNDRY & MACHINE
DETROIT MICH.

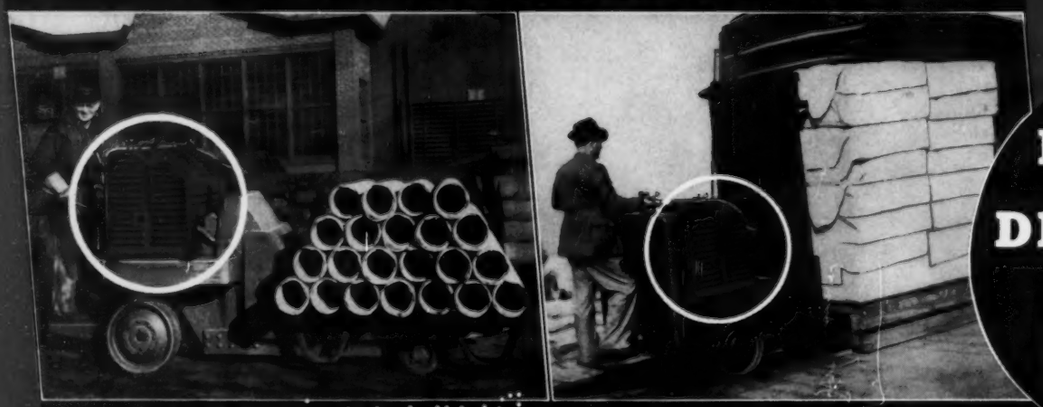
READY-POWER

EQUIPPED ELECTRIC TRUCKS SAVE TIME—SAVE MONEY GIVE BEST OVERALL PERFORMANCE



PROVIDES *Continuous Power*

PROVIDES *Peak Performance*



IT'S POWER THAT COUNTS

READY-POWER (Gas-Electric) units on new or existing electric truck equipment handle more loads per hour per day and per year than the same equipment battery powered. This means a saving in time as well as a saving in money by accomplishing a given amount of work in less time at a lower cost per ton handled. Thousands of users in all lines of activity have proven this. With today's higher wage rates and the accent on performance, be sure you get the best.

●

For new or existing electric trucks we manufacture a complete line of Gas-Electric power units—not complete trucks. You can secure new trucks complete with READY-POWER from all truck manufacturers or we can supply you READY-POWER units to replace batteries for the trucks now in your plants. Prompt deliveries are now possible.

Write for information mentioning type of new trucks contemplated, or make and type now operated.

PROMPT DELIVERIES NOW!

THE READY-POWER COMPANY

[illegible] DETROIT, MICHIGAN, U.S.A.

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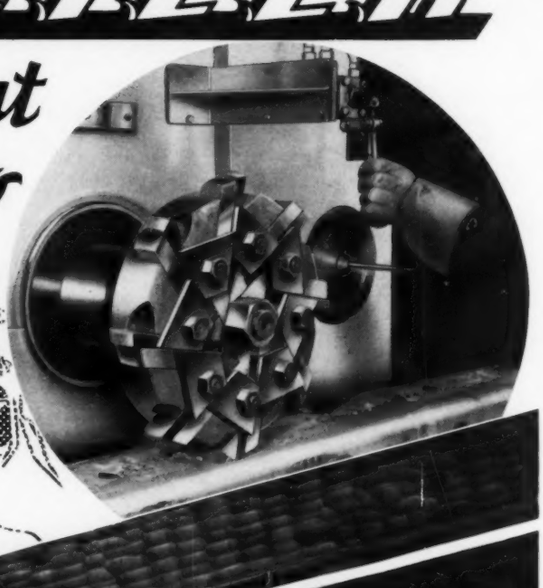
The BILLETEER

Cleans Billets at Machine Gun Tempo



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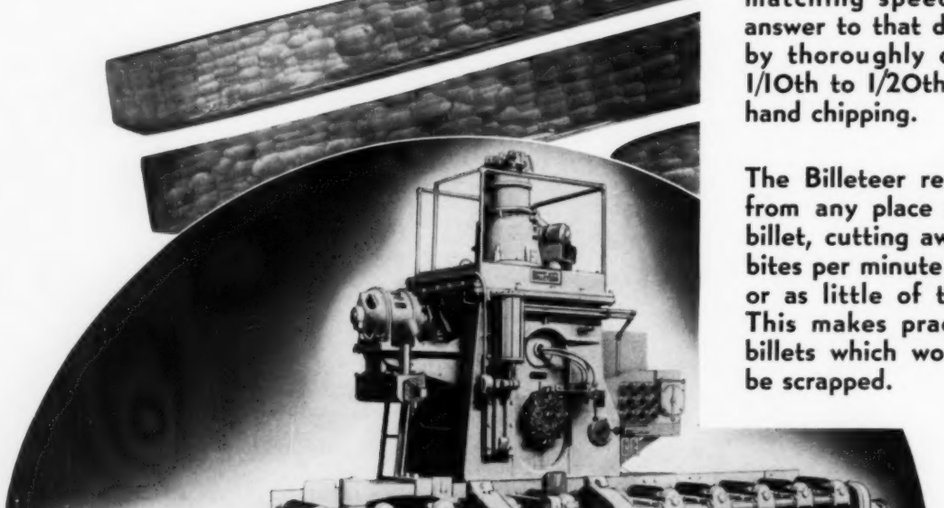

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IRON AND STEEL ENGINEER

JANUARY • 1942
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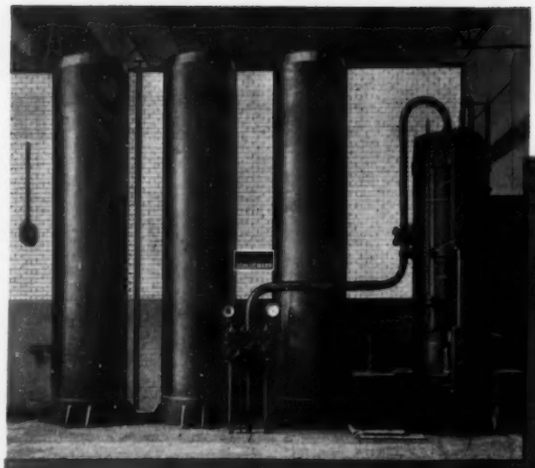
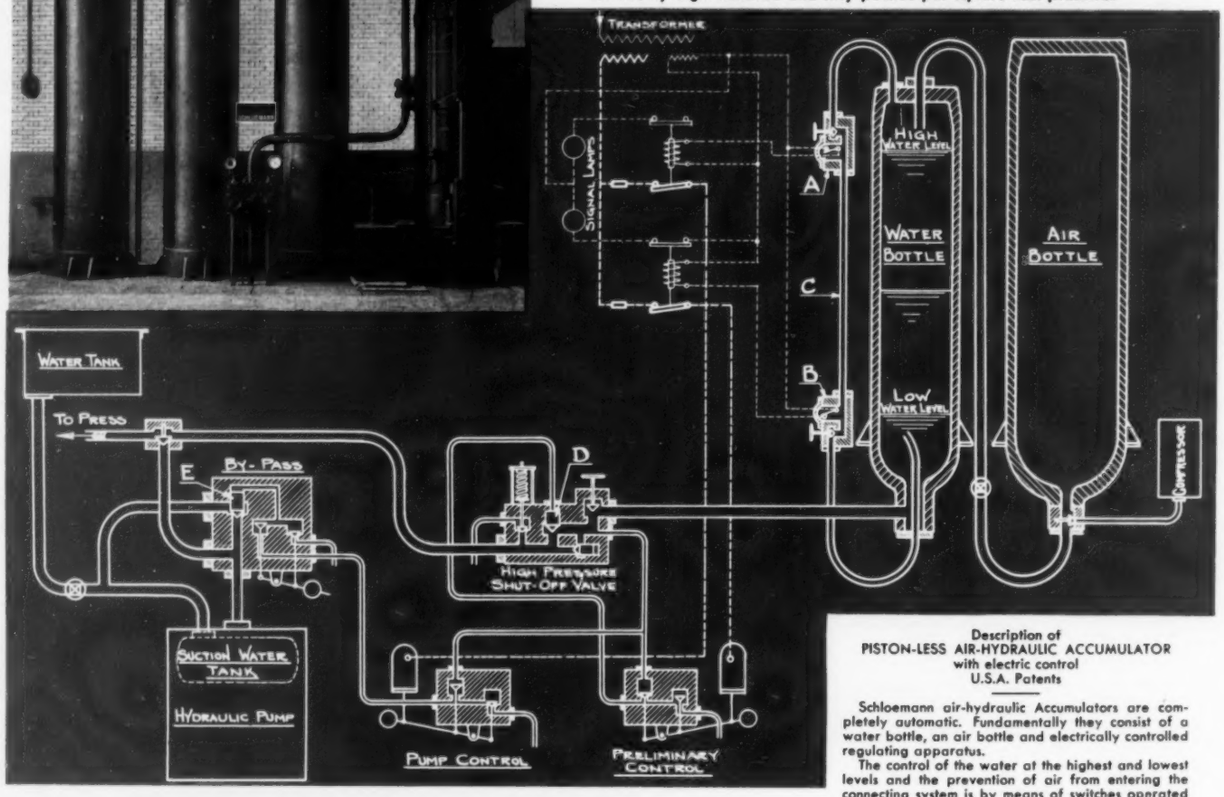


Accumulators furnished in sizes from fifty gallons to twenty-five hundred gallons and for pressures up to forty-five hundred pounds per square inch.

System shown at left has two hundred gallons capacity and is designed for twenty-eight hundred and fifty pounds per square inch pressure.



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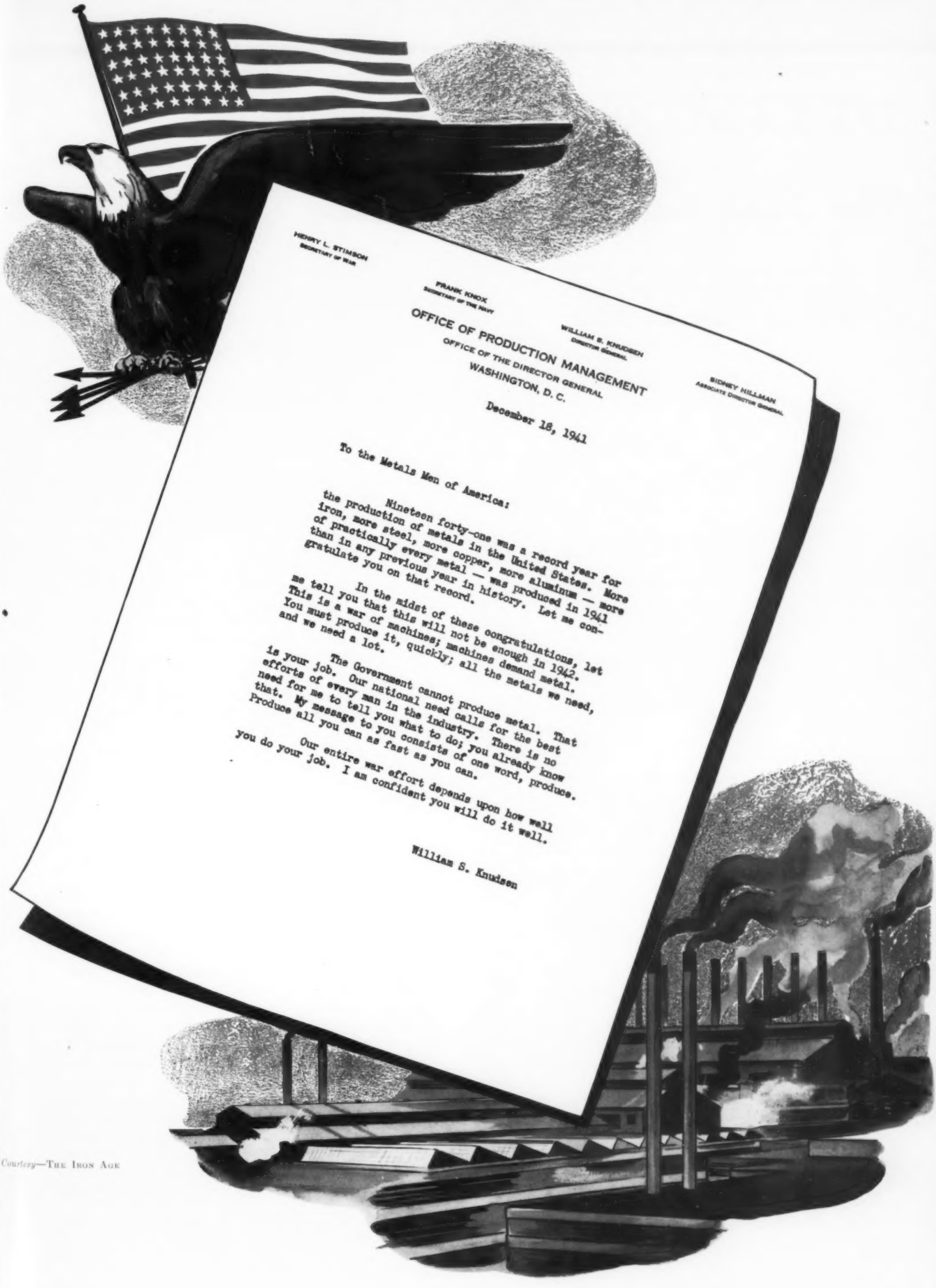

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WASHINGTON, D. C.

December 18, 1941

To the Metals Men of America:

Nineteen forty-one was a record year for the production of metals in the United States. More iron, more steel, more copper, more aluminum — more of practically every metal — was produced in 1941 than in any previous year in history. Let me congratulate you on that record.

In the midst of these congratulations, let me tell you that this will not be enough in 1942. This is a war of machines; machines demand metal. You must produce it, quickly; all the metals we need, and we need a lot.

The Government cannot produce metal. That is your job. Our national need calls for the best efforts of every man in the industry. There is no need for me to tell you what to do; you already know that. My message to you consists of one word, produce. Produce all you can as fast as you can.

Our entire war effort depends upon how well you do your job. I am confident you will do it well.

William S. Knudsen

Courtesy—The Iron Age

DEVELOPMENTS *in* *The Iron and Steel Industry* DURING 1941

By W. H. BURR, *Chairman*
A. I. S. E. Development Committee
and Electrical Superintendent
LUKENS STEEL COMPANY
Coatesville, Pennsylvania

▲ BREAKING all previous figures for the industry, the year 1941 shows a total production estimated at 82,900,000 tons of ingots, composed approximately of 74,300,000 tons of open hearth steel, 5,600,000 tons of bessemer steel, and 3,000,000 tons of electric steel. Iron products, ever essential to war, have become even more important in the highly mechanized warfare of today. History, now repeating previous cycles, shows a record, almost without surcease, of strife over control of reserves of materials required in the manufacture of iron and steel. The present war, bringing marked alterations in the geography of the European continent, has materially changed the control of raw material reserves, as well as the capacity for converting them into iron and steel commodities.

In a paper before the A. I. S. E. 1941 Convention, Charles Hart estimated that Germany, be securing domination of the various European states, has increased her iron ore reserves eight-fold over those held at the close of World War I. Likewise, ore mining capacity has been increased seven-fold, pig iron production capacity has been doubled, and steel making capacity has been increased two and one-half times. Including the capacities of Italy and Japan, Axis capacity now totals about 45,000,000 tons of pig iron and 60,000,000 tons of steel per year. Against these figures, the United States, Russia, Canada, and the United Kingdom show annual capacities totaling about 85,000,000 tons of pig iron and 130,000,000 tons of steel.

Perhaps the past year will best be remembered in the history of the iron and steel industry as the year of questions. Certainly as never before—and perhaps never again—have problems been heaped upon the industry, from the top down, imposing questions of policy, of capacity, of operations, of labor—and the obscuring haze of uncertainty makes all of these questions extremely difficult to answer.

It would seem that the question of greatest long-range significance is that of steel plant capacities. Determination of production capacity in itself is a relatively simple matter. The accompanying chart, produced by the Office of Production Management, shows total existing capacity, plus increases privately financed and actually approved for government financing, which will not be completed until the latter part of 1943. It should be noted that these are rated capacities, and that it has been rather generally agreed that operations may be carried on at 102½ per cent of this figure. Thus, our present capacity may be taken as about 88,200,000 tons of ingots per year, with an expected 95,500,000 tons by the end of 1943.

The determination of steel requirements, however, is apparently not so simple. Various estimates of 1942 requirements have been made, running up to an incredible 120,000,000 tons. Armament requirements, including exports to the United Kingdom, etc., have been variously gauged at 20,000,000-30,000,000 tons. Even with the higher allocation for defense purposes, 60,000,000 tons remain available for civilian consumption—a not inconsiderable quantity, exceeding our 1940 civilian consumption.

Recently, however (and but a few years since the industry was the target for much criticism for over-expansion), the Supply Priorities and Allocations Board in Washington has approved a 10,000,000 ton expansion program. This is in line with the opinion of many government advisors, though not in conformation with the ideas of a great part of the industry.

OPM authorities state that this plan will cost $1,250,000,000 and will be completed in two years. The projects will be financed by the Reconstruction Finance Corporation through the Defense Plant Corporation, who will probably retain title to the new facilities. This proposal includes various increases, totaling about 3,000,000 tons, already approved.

It is the belief in many quarters that this expansion is not essential. Some feel that it could not be completed in time to aid in the national emergency. Others question the wisdom of consuming perhaps 4,000,000 tons of ingots of our present production in building the new facilities with their auxiliaries. Even the labor

W. H. BURR

the various projects totaling about 15,000,000 tons per year. About ⅔ of this is in the nature of expansions of existing plants, and the balance represents construction of new plants.

As an aid to increasing production, the every-growing variety of chemical compositions and physical requirements of steel specifications was surveyed by various technical committees, resulting in a greatly simplified schedule of standard steel types. Standard specifications for carbon and alloy steels have been formulated, and it is believed that the entire final significant list will contain about 200 specifications. This is in line with the practice in use in England and Germany, where, it is reported, practically all steel requirements are filled from lists of, respectively, 82 and 108 significant steels. This move should do much to aid production and expedite deliveries.

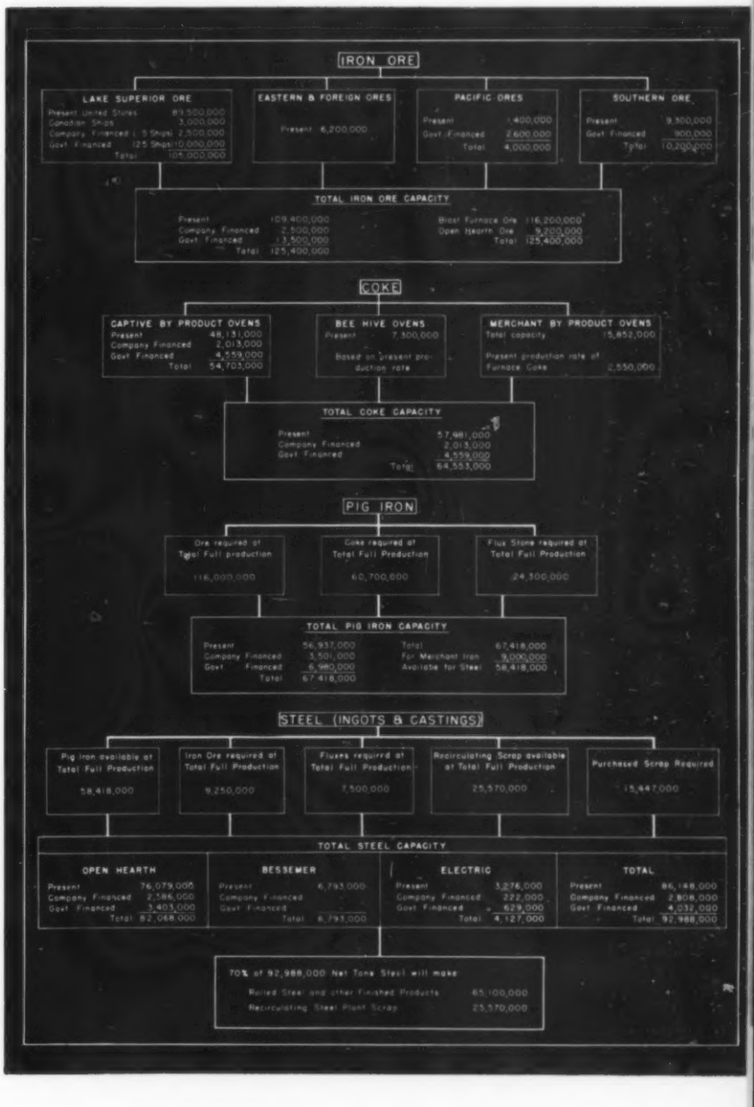
Another question of immediate significance concerns the supplies of certain strategic metals necessary for the supply has been questioned. Perhaps the most concrete objection is that the scrap supply of the country shows distinct evidence of inadequacy. At various times through the year, steel producers have reported some curtailment of ingot production due to scrap shortages. Unsuitable type of scrap has also been blamed for some impairment of operating efficiency. It is stated, no doubt truly, that immense quantities of scrap are scattered over the country, but that its accumulation presents a difficult problem. One school of thought holds that a price rise would bring much of this scattered supply together. Others hold that price ceilings should remain unchanged, but the collections should be subsidized by the government. Whatever course is taken, the fact remains that the often expressed criticism of our scrap exports of the past five years was well founded —particularly when it is recalled that, of the more than 17 million tons of scrap exported in the past five years, over 10 million tons went to countries now aligned against the United States.

Our present scrap usage in open hearth furnaces is at the rate of perhaps 42,000,000 tons per year, about 45 per cent of which (19,000,000 tons) must be purchased. It has been estimated that our ingot production for 1942 and 1943 will be limited to 83,000,000 and 86,000,000 tons, (or less) respectively, by scrap deficiency. Blast furnace construction already under way is expected to make up this shortage by 1944, insofar as present steel capacity is concerned, but additional ingot expansion will require still more blast furnace capacity.

The tremendous slag dumps which have accumulated around many of the older plants in the country represent a source of scrap metal. The metallic content of these dumps averages between one and two per cent, and much of this may be recovered by hand picking or magnetic separation. The operation is effected more readily in older dumps which have weathered into a loose crumbly condition.

Nevertheless, upon request, the steel companies have submitted definite proposals for expansion of capacity,

This chart, prepared by the Office of Production Management, shows total existing capacity plus added capacity privately financed and approved for government financing as of November, 1941.



production of steel. Perhaps the most important of these is manganese. At present, about 75 per cent of the manganese used in this country is imported. It has been stated, however, that there are large deposits of low grade manganese ore available in this country, the development of which can be effected should economics or an emergency require. Approximately 12.5 lb of manganese is used per ton of steel produced. In discussing the manganese situation, C. H. Herty outlined the conditions which determine its use in steel making as follows:

1. Specifications set by the consumer.
2. Specifications set by the producer to meet physical properties.
3. Specifications set by the producer to give the best rolling conditions.
4. Open hearth practice as regards the charge, working of the heat, and deoxidation practice.

Manganese consumption can be reduced by suitable revision of consumer specifications, balancing the lower manganese with carbon or silicon, or both. This might require modification of the heat treatment or a revision of requirements of tensile specifications. Also, in some cases, phosphorus, within normal commercial limits, can replace manganese in its effect on tensile strength. Again, relaxation of consumer requirements as to product surface, combined with extra precautions by the producer to reduce sulphur, will also allow a reduction in manganese.

Open hearth practice can be regulated to conserve standard ferro manganese by increase of the manganese content of the charge, by reducing slag volume, by carefully controlling the slag so as to conserve possible residual manganese and give maximum recovery of additions, by deoxidation of the heat before the addition of manganese, by making additions in the ladle insofar as possible, and by the substitution of manganese alloys lower in manganese than standard ferro manganese.

While practically all chromium is imported at present, ore deposits in this country may serve to lessen the shortage in this material. Molybdenum, to a limited extent, may be used as a substitute for chromium. Tungsten is about half domestic, half imported, and an increase in its production may be expected. Molybdenum is also substituted for tungsten to a certain extent. Fortunately, our domestic production of molybdenum will be adequate for our requirements, and the same may be expected of our vanadium situation. Nickel, which is all imported, is an alloying element for which adequate substitution is difficult.

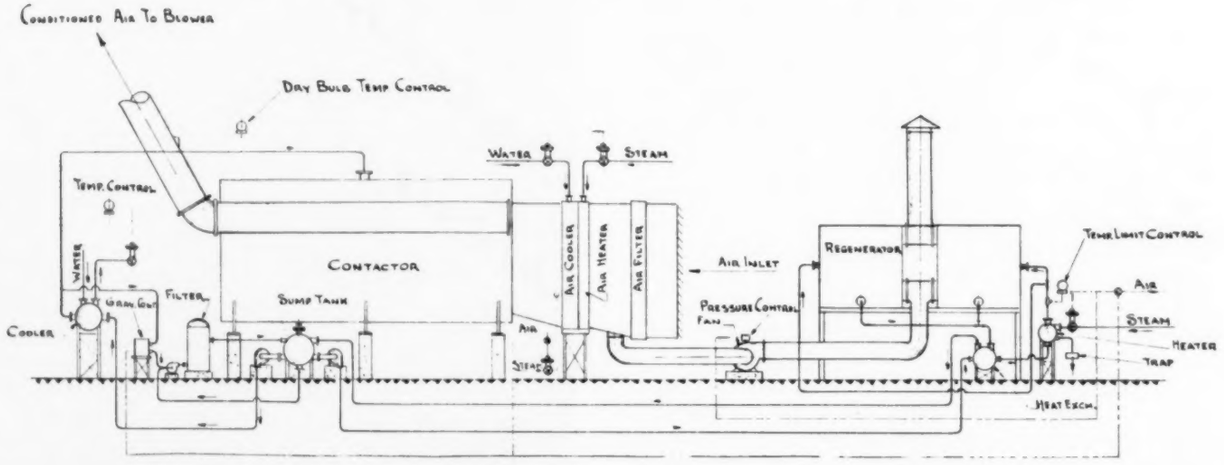
Thus, should it become necessary to rely entirely upon domestic supplies of the alloying elements, sacrifices in physical properties and serviceability of some steels must be expected. Stocks of these materials have been accumulated, and are gradually being increased insofar as possible.

Expansion of synthetic magnesite production is expected to render the United States independent of imported natural magnesite from Austria and Manchuria. The process consists essentially of replacing the lime content of calcined dolomite rock with magnesia through reaction with sea water. A specialized technique puts magnesium hydrate into a crystalline form, readily filterable and separable from the sea water and the various salts dissolved in it. It is felt that demands for magnesite in the basic steel industry can be fulfilled.

COKE PLANTS AND BLAST FURNACES

Total production of coke (by-product and beehive) has been estimated as 65,000,000 tons for 1941. Figures gathered by the Bureau of Census indicate a total annual potential coke producing capacity, at the year's end, of about 72,000,000 tons, including 2,000,000-3,000,000 tons of beehive capacity requiring repair. The OPM survey shows an annual capacity of 64,553,000 tons of furnace coke per year, including 6,572,000 tons under construction. Blast furnace coke consumption during the past year may be placed at approximately 50,000,000 tons, indicating no immediate shortage. However, blast

Diagram showing general arrangement of absorption type plant for conditioning air supplied to the blast furnace.



furnace expansion, approved and under consideration, will increase this consumption materially. Throughout the year, new coke oven projects have been announced, most of them calling for complete new batteries, with some plans in the nature of additions to existing batteries, and some rebuilding and rehabilitation of old batteries.

Beehive ovens in excess of 7,000,000 tons annual coke capacity are still in use, representing an unfortunate waste of valuable by-products.

The heavy demand for coke has put all ovens on practically a minimum coking time, with an accompanying sacrifice of uniformity of product and changes in coke characteristics, all of which affect blast furnace operation.

An improved type of conveyor belt for coke wharf service has been placed on the market. This belt is designed with a double thickness of cover over the areas of greatest wear on both the top and bottom of the belt, so that when abrasion wears one side down, the belt can be turned over, and additional service obtained from the untouched cover area on the other side. The covering, which is made of a compound offering high resistance to aging and abrasion, is $\frac{1}{4}$ in. thick on top and bottom in wearing areas, and $\frac{1}{8}$ in. thick over the remaining width. These thicknesses may be varied to suit unusual service conditions.

Pig iron production for the past year has been projected at a figure of about 55,800,000 tons, pointing to an average operating rate for the year of about 97 per cent. A shortage of blast furnace capacity, particularly in view of the scrap shortage and proposals of increased ingot capacity, is clearly indicated, and an addition of 2,000,000 tons is under construction. An additional 6,500,000 ton increase is planned. This expansion will call for additional ore mine facilities, ore carriers, ore unloaders, etc.

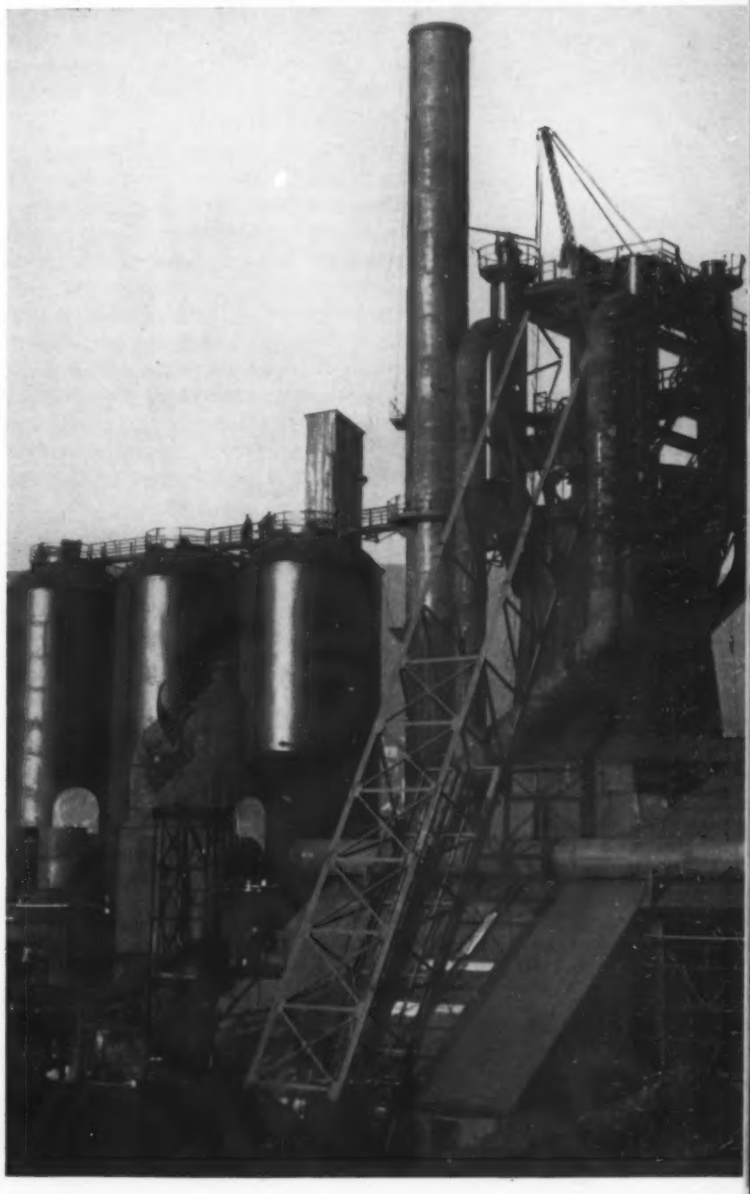
Rehabilitation of blast furnaces has proceeded at an accelerated rate throughout the year. Perhaps the most noteworthy thing about these programs is the speed with which they have been accomplished, reports of 50 to 60 days being in evidence. Several furnaces, long idle and practically dismantled, have been rebuilt and put into operation. Several more furnaces are to be moved from their old locations to points where they will serve more efficiently, saving much time over that required for new construction.

It has been indicated that some increase in production can be gained by the installation of blast conditioning equipment, reducing the moisture content of the air supplied to the furnace to a low, constant quantity. The application of blast conditioning equipment on blast furnaces has expanded very materially during the past year. This equipment falls into two general groups, one employing sprays of water which may be refrigerated, while the other removed moisture by absorption. One system uses a combination of refrigeration and absorption. Various types of installations have been made, and reports indicate satisfactory operation. One design of the refrigerant type uses a water-cooling system, cooling the water which is sprayed in the second stage of the dehumidifier. A recirculating pump takes water from the second stage and recirculates it through sprays in the first stage. For more complete removal of moisture, the initial sprays may use water at 85-100 F from some external source, while the remaining stages may be supplied with refrigerated water.

The absorption type of equipment is designed to remove water vapor and dirt from the air. The vapor is removed by absorption through contact with a hygroscopic salt solution. Heating and cooling coils ahead of the dehumidifier maintain the predetermined outlet air temperature, depending on solution concentration and available cooling water. The water vapor picked up by the solution is then, in a constantly operated closed cycle, driven off by heat supplied in steam coils so that the solution is maintained at the desired specific gravity. Dirt is removed from the air by a continuous air bath filter.

The modern use of blast conditioning started in the

Typical of the modern blast furnaces being added to the country's capacity is this new unit, with an annual production rated at 400,000 net tons of pig iron.



southern district of the United States, but a number of installations have been made in the northern states, and more are on order. One northern producer reports an increase in production of about 16 per cent during the summer months, as well as decreased coke consumption and a more uniform quality of iron, from furnaces provided with dehumidifying equipment. It is felt that the increased production over the period of a year will not be less than 8 per cent. Two schools of thought prevail in regard to blast conditioning, one maintaining that a reduction to about 3 grains per cu ft is sufficient, as long as the remaining moisture is constant; the second group holds that moisture removal should be carried down to one grain, or less, per cu ft. Both groups advance arguments supporting their theories. Additional operating data will be needed in order to make an accurate decision as to the relative merits of these arguments. Perhaps it is significant that of seven manufacturers offering dry blast equipment, five offer equipment capable of reducing moisture to about one grain.

Quite a number of blast conditioning installations have been announced during 1941, and the increased production shown by present installations should prove a welcome addition to the country's capacity—an addition which can be made in less time and with less expense than other methods of expansion.

Further increases in blast furnace output may be obtained in beneficiation of the raw materials. A goodly number of preparation plants and sintering plants have been built and are under construction. One plant is designed to crush and size all ore going to the blast furnaces installed there—about 13,000 tons per day. Fines will be sintered together with the flue dust produced by the furnaces. The sintering plant has a capacity of about 4,000 tons of sinter per day, making it the largest in the world. In this preparation plant, ore is dumped by a car dumper over grizzly bars into two gyratory crushers, and is conveyed by belts to four secondary crushers. The ore is next discharged through six screens, making three sizes. The two largest sizes may be mixed in desirable blends, while the fines are sintered with furnace flue dust.

A list of pit iron specifications brought out by the American Iron and Steel Institute has been generally adopted and has done much to eliminate many of the unusual—and perhaps uncalled for—specifications often encountered by furnace operators, particularly in the merchant iron field.

STEEL MAKING

The practice of external desulphurization of hot metal continues to receive attention. It has been rather clearly demonstrated that high sulphur coke can be used in the blast furnace without carrying excessive slag volume or strongly basic slag, as the sulphur content of the iron can be economically and easily removed by the use of soda ash. The method of adding the soda ash should give most intimate contact between iron and soda ash for sufficient length of time to complete the reaction. The effect of this treatment on elements other than sulphur is small, and practically negligible. Tests based on the practice of manufacturing basic open hearth iron indicate that a regulated feed of soda ash to the metal as it flows in the runner reduces the sulphur more efficiently than treatment in the ladle or mixer. The higher the original sulphur, the greater the percentage of its reduction. Some provisions should be made for removal of fumes resulting from the treatment.

Additional tests on the effect of the soda ash treatment of hot metal in the open hearth seem to show no adverse results, and no detrimental effects were noticeable on steel quality. The process of external desulphurization is particularly practical where high sulphur coke is used in the blast furnace, or where unusually low

The starting of many new electric arc furnaces, as illustrated here, has raised the country's electric steel ingot capacity to over 4,000,000 tons per year.

sulphur (below .20 per cent) is required in the steel plant.

After the lull in new open hearth construction of 1940, the past year brought a reawakening in this field and several new installations have been completed and others are in progress. Expressions from open hearth operators indicate a preference for furnaces having tapping capacities of 150-175 tons. However, relatively deep baths materially lengthen the refining and finishing periods of a heat, and a maximum depth of about 36 in. seems to be preferable. Typical of these trends are new 150-ton furnaces in the Chicago district. About 70 ft overall length and 22 ft overall width, the furnaces are 44 ft 1 in. long, knuckle to knuckle, and have sloping backwalls. Regenerators and slag pockets are fully insulated and encased. The furnaces are fired by preheated mixed blast furnace and coke oven gas through retractible ports. Complete automatic control is provided, including fuel-air ratio, furnace pressure, and automatic reversal by differential checker temperature.

The use of basic ramming mixtures for furnace bottom construction has widened materially. Originally designed for electric furnace hearths, magnesitic mixtures containing chemical bonds giving an air set when mixed with water have been found very applicable in the open hearth. The material was first used for patching during furnace rebuilding. It has also some use for hot repairs, although thus losing the beneficial results of ramming. Considerable installation time is saved by the use of rammed sub-hearths, and open hearths have been constructed with as little as 1½ in. of magnesite on top of the rammed sub-hearth. Other applications in the open hearth include its use over clay brick in sloping backwalls, as a protective coating for port slopes, as door lining, etc. The material has also found application in various heating furnaces, such as soaking pits, heating furnaces, and continuous butt-weld tube mill furnaces.

Improvements continue in the production of steel by the bessemer process. The use of the photo-cell control system mentioned last year has widened to a marked extent. Giving a rapid quantitative indication of changes in the bessemer flame, this control is usually formed of three photo-cell tubes set up about 60 ft from the flame, so the field of view includes the whole flame. The filter finally adopted is a combination of two filters; one which might be termed a heat-absorbing filter, the other, an ultra-violet absorbing filter.

Tests on physical properties of bessemer steel as compared to open hearth steel show the former to have impact strengths fairly comparable for any given ultimate strength, even though possessing coarser structural grain size. These tests have also indicated the importance of temeprature control and degree of oxidation in the process. Variations in chemical analysis and physical temperature of the iron used may be compensated for by the addition of scrap to the metal bath in the early part of the blow, by the introduction of steam into the blast main as a coolant, or by tipping the convertor for side blowing to increase the temperature. The best teeming temperature is indicated to be 2,860-2,890 F. It was further shown that oxidation of the bath increases rapidly at the end of the blow, and may double in 10-15 sec. Thus, close control is essential at this period of the heat.

It is felt that bessemer steel can take an important part in the production problems of the industry, replacing open hearth steel for many uses, and liberating open hearth capacity for more exacting products. Some use is being made of bessemer convertors to produce a "synthetic" scrap. This is a ramification of the duplexing process, which may well find a role of increased importance in the general picture.

The phenomenal growth of the electric arc furnace capacity, mentioned in this review last year, has proceeded throughout 1941 at an even faster rate. Annual capacity of the United States (including several furnaces under construction) may be taken as over 4,100,000 tons, excluding some general foundry capacity. Some twenty additional furnaces, totaling about 1,250,000 tons annual capacity, are under consideration. Thus,

This new 150 ton open hearth frunace at Wisconsin Steel Company was lighted September 16 and will add 160,000 tons per year to the nation's steel making capacity.

a total capacity of about 5,500,000 tons of electric steel per year is projected. These additions, actual and projected, are scattered over the industry, including some companies not previously producing electric steel. Due to the interest evidenced in this particular phase of the industry, the accompanying tabulation of ingot-producing electric furnaces of the United States is reprinted from the IRON AND STEEL ENGINEER, October, 1941.

In this table, nominal furnace sizes are given as reported in general usage by the various companies, and do not represent holding capacity or production rate. In practically every case, furnace charges exceed nominal ratings by 30-50 per cent, and even 100 per cent in the case of the smaller furnaces. The largest furnaces among the later installations are nominally rated at 70 tons, but actually take charges of about 90 tons. Annual capacities of the various installations were estimated from typical conservative full-time performance on double slag heats of high-grade steel, with due consideration of probable effect of furnace diameter and transformer capacity. Productive capacity may be increased by 50 per cent or more for single slag heats and may be decreased 25-35 per cent on the "stainless" grades. The use of molten charges, or duplexing, will also greatly increase production, and is being practiced in some cases.

In modern practice, transformer capacity ranges from 600 kva for the nominal ½ ton furnace up to 15,000 kva for the 70 ton furnace, or from 600 kva to 170 kva per ton of furnace charge. The values decrease as furnace size increases. Transformers for this service are oil-immersed and water-cooled, and are provided with motor-operated secondary tap changers giving 8 or more secondary voltage steps, ranging from about 110 volts to 275 volts. Each transformer application is a special problem, and the design should be tailored to suit each particular installation. Furnace electrodes are commonly of graphite except in some of the older, smaller furnaces. Their diameters range from 4 in. to 20 in., varying with the kva capacity of the transformer.

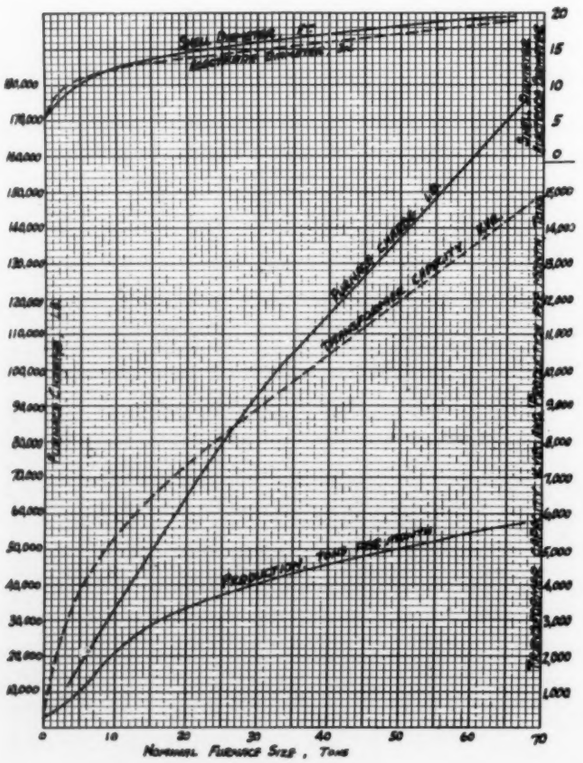
Over a considerable period of time, numerous tests have been made to measure the voltage surges which occur in probably every arc installation. These tests have shown that, when the magnetizing current of the furnace transformer is opened by a circuit breaker, it is possible to get transient overvoltages, whose magnitudes depend on the point in the cycle at which the circuit is opened and on the characteristics of the transformer circuit. The connection of capacitance, large in comparison with the capacitance of the transformer windings, between the transformer and the circuit breaker has been shown to materially reduce the magnitude of these surges. This practice has been used in several cases, although most installations depend on a good margin of over-insulation of the switching equipment and transformers used in arc furnace applications. Circuit breakers designed for a potential rating 50 per cent (or more) greater than the primary voltage of the transformer are usually adequate in this service.

A tendency toward the use of specialized high-frequency melting furnaces is pronounced in melting high-alloy tool steels, centrifugal castings, and magnet steels, and a maker of high-frequency steel melting furnaces in this country advises that 20,000 kw of melting furnace units are installed or virtually ready for completion at the close of 1941. Certain types of steel alloys, it is stated, cannot be melted, cast, or handled by any other means. Thus, it is now estimated that 3 per cent of all the high alloy steel tonnage in this country is melted in the high-frequency induction melting furnace.

Rapid determinations of phosphorus in steel and cast iron may be made by a method developed by the National Bureau of Standards. The sample is dissolved in diluted nitric acid and the phosphorus converted to the ortho acid by fuming with perchloric acid. The interference of iron is avoided by reducing it to the ferrous ion with sodium sulphite. The phosphate ion is then converted to the blue compound by adding a solution containing hydrazine sulphate and ammonium molybdate and heating at 90 C for about 5 min. The transmittancy of the colored solution is measured with a photo-electric colorimeter and a Corning "lantern shade yellow" filter. The quantity of phosphorus is determined from a standard curve or table prepared from data obtained by treating steels of known phosphorus content in the manner outlined.

A study of factors affecting mould life indicates a high manganese content in mould material to be detrimental, while a high silicon-manganese ratio seems to be favorable. A graphitic carbon content of 2.8-3.2 per cent seems preferable, as does a low ratio of combined carbon to total carbon content. A high degree of taper and a high ratio of height-thickness are design factors

Characteristics of modern electric arc furnaces are approximately as set forth in this chart.



conducive to long mould life, and a ratio of mould weight to ingot weight of 1:1 or greater than 1.0:1.3 seems desirable. Prompt stripping of ingots tends to increase mould life.

A recently patented process entails the blowing of absolutely dry, pure corn sugar on the inner surface of ingot moulds. This coating is said to prevent metal splashes from solidifying on the mould walls, acting much as the pitch, tar, etc. in common use. The use of sugar gives a shiny caramel coating, which disappears in subsequent processes.

An ingot car of new design has a body of about 16 ft in length, constructed of heavy slabs welded into a single unit, with protection plates in several separate sections bolted to the car body to prevent damage from molten metal. The compensating-type trucks, which are easily removed, are spring mounted with limiting features to prevent excessive spring strain from over travel of stripper and pit cranes. Truck frame flexibility allows the wheels to meet any irregularity in the tracks. Free vertical movement of the wheels is permitted without twisting of the truck, the wheels may move independently of the side frames, and the truck frames may move vertically independent of each other. Wheels are of forged steel with wide treads. The use of large ingot cars allows a reduction in pouring platform requirements, and in trackage at mould yards, stripper, and soaking pits.

The use of carbon and graphite products in the iron and steel industry has been further extended during the past year. The success achieved with carbon ingot mould plugs has led to the use of carbon stools. This has resulted in noticeable improvement in ingot grain structure adjacent to the bottom of the mould and in the reduction of "cone" formation. Split moulds, made entirely of carbon or graphite has proved economical in the casting of alloy steel ingots. Ceramic inclusions are avoided and, with graphite moulds, an exceptionally fine ingot surface is obtained. Carbon linings for blast furnaces and carbon brick trough linings have proved both practicable and economical.

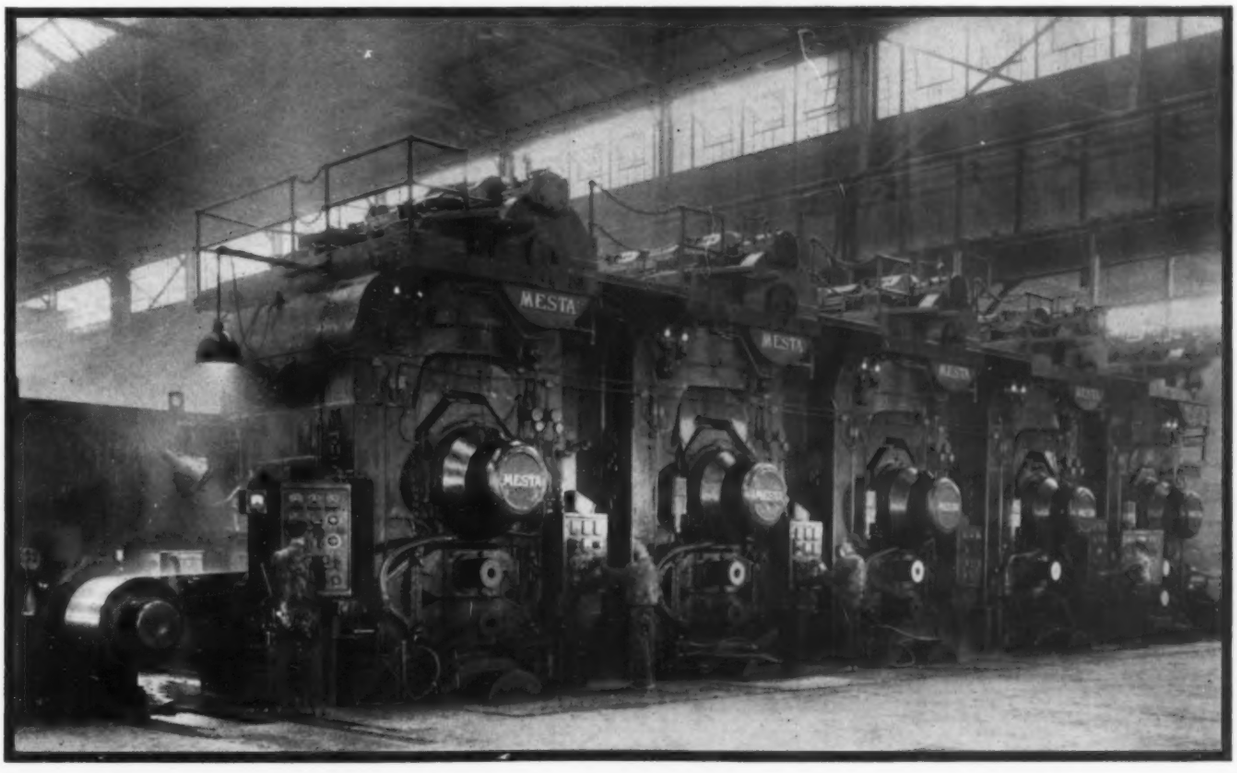
Resistance to chemical reaction and thermal shock make carbon Raschig rings the ideal tower packing material for hydrogen sulphide removal units. Carbon and graphite pipe for heating pickling solutions, together with carbon rolls and graphite bearings used in pickling and electroplating processes, are indicative of the advantages of corrosion-resistant properties that carbon and graphite offer to the iron and steel industry.

In addition to the regular grades of carbon and graphite, which have appreciable porosity, both materials, by special treatment, can be made impervious to seepage of either liquids or gases. Grades of increased porosity and high permeability are also manufactured. These are exceptionally effective for gas dispersion as well as for filtration. Porous carbon tubes are ideal for heating corrosive liquids with steam. They dissipate the steam in minute bubbles, assuring practically complete absorption while rising through the liquid.

ROLLING AND FORGING

New mill installations in the steel industry during 1941 were confined principally to some cold strip mills, with some activity in rod mills. It is generally felt that the rolling capacity of the industry is sufficient, even with an appreciable increase of basic steel productive capacity. There are, however, bottlenecks in some particular lines, the most important being in our plate

This tandem cold strip mill, put into production this year, represents a new high in speed and drive power.



STEEL-MAKING ELECTRIC FURNACES

INSTALLED OR UNDER CONSTRUCTION

Company	Location	Number	Nominal size, tons	Approximate shell diameter, ft.-in.	Make of furnace	Transformer capacity, kva.	Diameter of electrodes, in.	Estimated annual capacity, tons
Allegheny-Ludlum Steel Corp.	Brackenridge, Pa.	2	35	16–0	Swindell-Dressler	10,000	18	
		2	25	15–0	Swindell-Dressler	7,500	18	
		2	6	11–6	Swindell-Dressler	3,000	12	
		2	6	11–6	Swindell-Dressler	2,500	12	
		1	6	11–0	Heroult	1,667	12	
		1	¼	....	Swindell-Dressler	175	4	284,000
	Dunkirk, N. Y.	1	15	12–0	Heroult	....	12	
		2	6	11–0	Heroult	....	..	65,600
	Watervliet, N. Y.	2	6	11–0	Ludlum	....	..	
		1	2	8–0	Ludlum	....	..	27,600
A. M. Byers	Ambridge, Pa.	1	15	12–8; 14–8	Heroult	7,500	..	36,000
American Rolling Mill Co.	Middletown, O.	1	6	11–0	Lectromelt	....	..	9,000
Babcock & Wilcox Tube Co.	Beaver Falls, Pa.	1	7½	12–0	Swindell-Dressler	6,000	..	18,000
Bethlehem Steel Co.	Bethlehem, Pa.	2	50	18–0	Lectromelt	15,000	20	
		1	25	15–0	Swindell-Dressler	7,500	18	
		1	6	11–0	Lectromelt	4,000	12	
		4	¼–½	....	Ajax Induction	....	..	180,000
	Steelton, Pa.	1	6	11–0	Heroult	2,000	..	9,000
Braeburn Alloy Steel Co.	Braeburn, Pa.	2	6	11–0	Heroult	1,500 and 3,000	..	18,000
Carnegie-Illinois Steel Corp.	Duquesne, Pa.	1	5	10–0	Heroult	3,000	..	8,000
	Johnstown, Pa.	2	3	9–0	Heroult	1,500	..	6,000
	South Chicago, Ill.	1	60	20–0	Heroult	15,000	20	
		1	30	15–8; 18–0	Heroult	12,000	20	
		3	20	15–8	Heroult	3,435	20	
		2	3½	....	Ajax Induction	....	..	190,000
Carpenter Steel Co.	Reading, Pa.	4	6	11–0	Swindell-Dressler	4,000	..	
		2	½	....	Northrup Induction	....	..	65,000
Colonial Steel Co.	Colona, Pa.	1	5	10–0	Heroult	2,000	..	8,000
Columbia Steel Co.	Torrance, Cal.	1	3	9–0	Heroult	....	..	7,000
Columbia Tool Steel Co.	Chicago Heights, Ill.	1	6	11–0	Lectromelt	....	..	
		1	3	9–0	Lectromelt	2,500	..	20,000
Connors Steel Co.	Birmingham, Ala.	2	3	9–0	Lectromelt	....	..	12,000
Copperweld Steel Co.	Warren, O.	1	35	17–0	Lectromelt	12,000	18	
		2	35	16–0	Swindell-Dressler	12,000	18	
		1	6	11–0	Lectromelt	5,000	17	
		2	6	11–0	Heroult	2,500 and 5,000	17	230,000
Crucible Steel Co. of America	Harrison, N. J.	3	15	14–8	Heroult	6,000	..	
		3	6	11–0	Heroult	3,000	..	
		1	3	9–0	Heroult	1,500	..	
		1	1	....	Ajax Induction	....	..	
		2	300 lb.	....	Ajax Induction	....	..	146,000
	Pittsburgh, Pa.	2	6	11–0	Heroult	....	..	
		3	1	....	Ajax Induction	....	..	32,000
	Syracuse, N. Y.							
	Halcomb Works	3	6	11–0	Heroult	3,000	..	
		2	3	9–0	Heroult	1,500	..	
	Sanderson Works	2	3	9–0	Heroult	1,500	..	61,000
Driver-Harris Co.	Harrison, N. J.	2	2	7–0	Heroult	....	..	8,000
Firth-Sterling Steel Co.	McKeesport, Pa.	2	3	9–0	Heroult	2,500 and 3,000	..	
		2	1½	....	Ajax Induction	....	..	17,000
Ford Motor Co.	Dearborn, Mich.	7	15	....	Heroult	....	..	
		8	7	11–6	Swindell-Dressler	(6) 2,500; (2) 4,000	..	
		4	5	10–6	Swindell-Dressler	(3) 3,000; (1) 4,000	..	
		2	3	9–0	Lectromelt	....	..	
		9	3	9–0	Swindell-Dressler	(3) 1,000; (3) 1,200; (3) 3,000	..	474,000
Henry Disston & Sons, Inc.	Philadelphia, Pa.	1	6	11–0	Heroult	2,500	..	
		1	3	9–0	Heroult	1,500	..	17,000

OF THE UNITED STATES OF AMERICA

AS OF AUGUST, NINETEEN HUNDRED FORTY-ONE

Company	Location	Number	Nominal size, tons	Approximate shell diameter, ft.-in.	Make of furnace	Transformer capacity, kva.	Diameter of electrodes, in.	Estimated annual capacity, tons
Heppenstall Co.	Pittsburgh, Pa.	2	1,200 lb.	....	Ajax Induction	....	..	2,000
Ingersoll Steel & Disc Co.	New Castle, Ind.	2	3	9–0	Heroult	1,800	..	
		1	5	10–0	Heroult	3,500	..	
		1	1	5–0	Heroult	1,000	..	16,000
Jessop Steel Co.	Washington, Pa.	1	6	11–0	Heroult	4,000	..	
		1	3	9–0	Gronwall-Dixon	2,500	..	17,000
Jones & Laughlin Steel Corp.	Pittsburgh, Pa.	1	1	6–0	Swindell-Dressler	1,000	..	4,500
Joslyn Mfg. & Supply Co.	Fort Wayne, Ind.	1	6	11–0	Lectromelt	6,000	..	13,000
Kilby Steel Co.	Anniston, Ala.	1	3	9–0	Lectromelt	2,500	..	
		1	1	....	Lectromelt	500	..	12,000
Knoxville Iron Co.	Knoxville, Tenn.	2	6	9–0	Lectromelt	3,000	..	19,000
Latrobe Electric Steel Co.	Latrobe, Pa.	2	6	11–0	Heroult	3,000 and 1,500	..	
		1	3	9–0	Heroult	1,000	..	
		1	1	5–7	Lectromelt	500	..	26,000
Lebanon Iron & Steel Co.	Lebanon, Pa.	1	3	9–0	Swindell-Dressler	2,500	..	7,200
Mesta Machine Co.	Pittsburgh, Pa.	1	15	13–6	Swindell-Dressler	5,000	..	33,000
Midvale Steel Co.	Philadelphia, Pa.	1	50	17–0	Swindell-Dressler	10,000	..	
		1	7½	12–0	Swindell-Dressler	5,000	..	
		1	6	11–0	Swindell-Dressler	2,250	..	90,000
National Forge & Ordnance Co.	Irvine, Pa.	1	10	12–0	Heroult	4,000	..	
		1	6	11–0	Heroult	2,500	..	
		1	2	7–0	Heroult	1,500	..	30,000
Northwest Steel Rolling Mills, Inc.	Seattle, Wash.	1	3	9–0	Lectromelt	2,500	..	
		1	6	10–0	Lectromelt	....	..	20,000
Northwestern Steel & Wire Co.	Sterling, Ill.	2	35	17–0	Lectromelt	....	..	100,000
Otis Steel Co.	Cleveland, O.	1	2½	7–0	Lectromelt	....	..	6,000
Pacific States Steel Co.	Oakland, Cal.	3	6	11–0	....	5,000	..	36,000
Pittsburgh Crucible Steel Co.	Midland, Pa.	4	35	15–8; 18–0	Heroult	....	..	216,000
Republic Steel Corp.	Canton, O.	2	70	20–0	Heroult	12,000	20	
		6	60	19–0	Heroult	12,000	18 and 20	
		2	35	16–6	Heroult	10,000	18	
		3	15	14–6	Heroult	4,500	14	
		1	6	11–0	Heroult	2,800	12	
		1	6	....	Induction	....	..	733,000
Rotary Electric Steel Corp.	Detroit, Mich.	2	50	18–0	Heroult	12,000 and 10,000	20	130,000
Rustless Iron & Steel Corp.	Baltimore, Md.	1	25	15–8	Heroult	7,500	17	
		2	15	14–6	Heroult	5,000	17	
		3	12	12–6	Heroult	3,500	17	168,000
Sharon Steel Corp.	Lowellville, O.	1	15	14–6	Heroult	6,000	..	36,000
Simonds Saw & Steel Co.	Lockport, N. Y.	3	6	11–0	Heroult	(2) 2,500; (1) 1,500	..	
		5	..	....	Ajax Induction	....	..	25,000
Texas Steel Co.	Fort Worth, Tex.	1	3	7–0	Lectromelt	2,000	..	
		1	8	10–0	Lectromelt	3,750	..	18,000
Timken Roller Bearing Co.	Canton, O.	1	85	20×29	Heroult	2×7,500	(6) 18	
		1	65	20–0	Heroult	12,000	18	
		1	60	19–0	Heroult	12,000	18	
		2	35	16–6	Heroult	10,000	18	
		1	20	14–8	Heroult	7,500	17	345,000
Union Electric Steel Corp.	Carnegie, Pa.	2	6	11–0	Swindell-Dressler	1,200 and 1,500	..	19,200
Universal Cyclops Steel Corp.	Bridgeville, Pa.	2	12	11–0	Heroult	3,000 and 4,000	17	
		1	6	11–0	Lectromelt	5,000	14	
		1	3	9–0	Heroult	2,000	9	75,000
Vanadium Alloys Steel Co.	Latrobe, Pa.	2	3	9–0	Heroult	2,500 and 1,500	..	
		1	½	....	Ajax Induction	....	..	12,000
Vulcan Crucible Steel Co.	Aliquippa, Pa.	2	3	9–0	Heroult	2,000 and 1,200	..	12,000
Total	.....	207	..	....	.....	....	..	4,169,100

Induction heating has been applied to the manufacture of shells, permitting partial heating for nosing.

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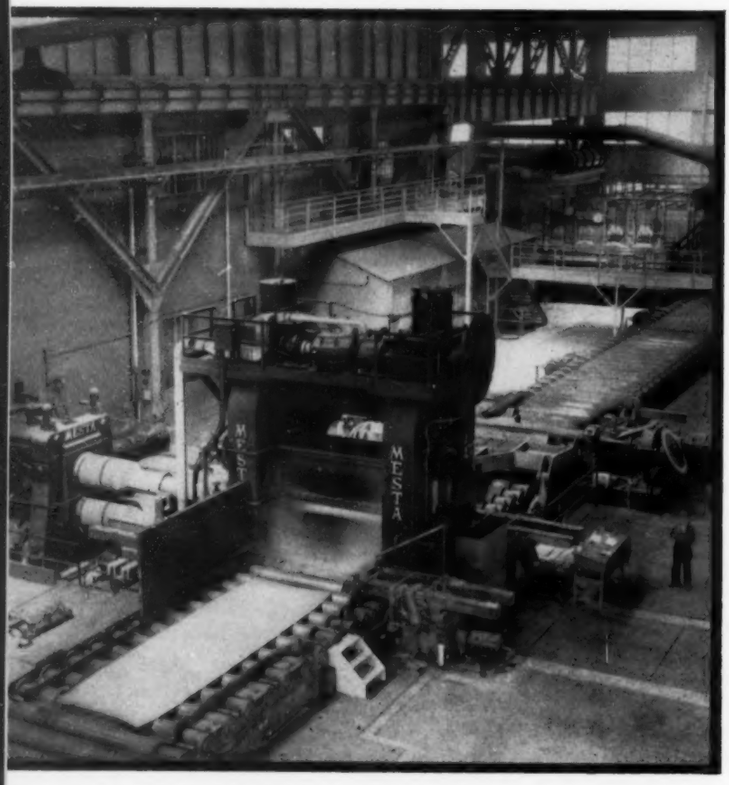
Several new plate mills will increase our plate capacity to a point which should be adequate for all possible demands.



rolling capacity. Carried to new highs by the demands for ships and tanks, our 1942 requirements have been estimated at 8,500,000 tons. Against this, we have a plate mill capacity of about 6,800,000 tons, however, the continuous wide strip mills of the country present a tremendous rolling capacity, and these mills can produce excellent light plate, ¾ in. thick or less, thus freeing regular plate mills for the heavier material. Arthur G. McKee, from a survey of the plate mill situation, has estimated that over 9,000,000 tons of plates can be produced in 1942 if the material is wisely specified and scheduled. Some plans have also been projected for additional large plate mills.

Some of the strip mills have already made slight changes to existing equipment so as to enable them to better produce light plates. One such change included the replacement of the parting shear by a heavier unit, lengthening the pilers to accomodate longer product, the installation of a new, heavy shearing line, and the installation of runouts and kickoffs on existing shearing lines. Other mills are proceeding with changes which will enable them to produce light plate, and it is believed that 30 per cent of the wide hot strip mill capacity can be light plates, and with the installation of some additional finishing equipment, even 50 per cent of the capacity can be devoted to light plate production. Meanwhile, plates have been placed under complete priority allocation.

Our report of a year ago mentioned the modernizing of two of the early hot strip mills. One of these projects has made little progress due to the press of business, while the other was completed in 1941. The latter represents a striking example of ingenuity, the mill being completely revamped, involving some new motors, the shifting of other motors, new generators, complete new switchgear, and new d-c runout tables and coilers. This change was made gradually with almost negligible interruption of regular operations.

A modern 5-stand continuous hot-strip mill was built for rolling aluminum and represents the first and largest of its kind. Each stand is driven by a 4,500 hp motor. Power is supplied from three 4,000 kw generators, each driven by a 5,800 hp motor. Voltage-maintenance control has been developed for hot-strip mills to give faster response and more accurate regulation.

A combination vacuum-tube and exciter control for flying shears, which eliminates the necessity of a mechanical tie to the last stand of a hot-strip mill, has been in operation for over a year. The results have surpassed the best expectations.

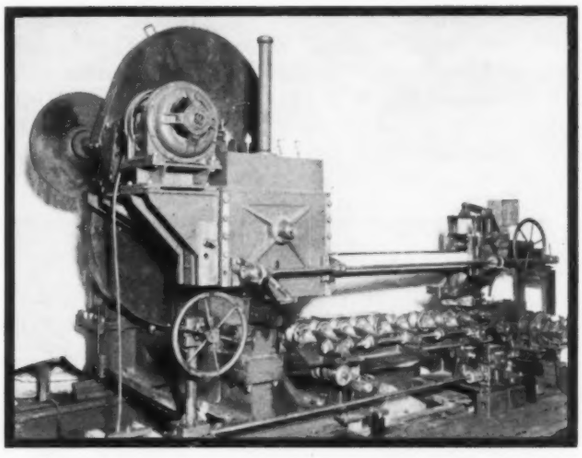
The world's fastest cold-strip mill, with a nominal operating speed of 3,300 fpm and a maximum speed of 3,850 fpm, went into successful production early in 1941. Tinplate has already been rolled successfully on it at 3,750 fpm, and it has broken all records for production. It is the highest-powered cold-strip mill, being driven by 11,400 hp, requiring an 8,000 kw motor-generator set. The two 4,000 kw generators for this set are the first d-c generators of so high a rating. Forced lubrication on this set, which is driven by a 12,000 hp synchronous motor, makes it possible to start with less than normal kva even though neutral reactor starting is used.

The motors for driving the stands employ "offset" poleface windings for the first time. With these special

windings, almost perfect compensation can be obtained for armature reaction which tends to give the motor a rising speed characteristic if not properly compensated for. Thus, with almost perfect armature reaction compensation, it is possible to use full compensation for IR drop in the motor armatures without fear of obtaining a rising speed characteristic which is fatal to any tandem mill. With this combination of armature reaction and IR compensation, almost perfect speed regulation is obtained at all speeds, and accurate tensions are obtained at all times during acceleration, running, deceleration, and threading.

These IR compensating boosters are controlled by amplifying exciters which give much more accurate and faster response to changes in armature current than the conventional methods of controlling through ordinary exciters. These circuits are so arranged that there is a very definite stabilizing effect on the individual motor speeds, extremely important on a high-speed mill of this nature.

The motors are designed with such a low WR^2 that



This vertical shear, readily introduced into a production line, cuts across the diagonal of the billet, reducing deformation of the stock.

it is possible to accelerate the mill to maximum speed in six seconds and decelerate it in four seconds. This has been made possible by designing all motors—except that driving the No. 1 stand—for direct connection, by using double-armature construction on the motors for driving the No. 4 and No. 5 stands as well as the reel, and by using a special "fluted" armature construction which enables the use of much smaller armature diameters.

The control system includes many features such as tension control between stands, tension control for the winding reel, indirect excitation of the motors, and close control of voltage during threading, acceleration, running, and deceleration.

A novel three-stand tandem mill is being built for rolling strip up to 16 in. wide at a speed in excess of 2,000 fpm. The stands are driven by motors of 1,250 hp, 1,500 hp, and 1,000 hp, respectively, and the reel by a 200 hp motor. This probably represents more power applied to a mill of this size than ever before. In addition to the features described just previously, this mill is equipped with special reel control. Since this mill will roll an extremely wide range of products, a regulating tensiometer is required for the reel to control the tension accurately.

Regulating tensiometers for the two tension reels of a reversing cold-strip mill were placed in service during 1941, with good results. This represented the first application of this kind, and was employed because of the wide range of tension control required. Several new reversing cold-strip mills have been built with improved control of voltage, inertia compensation, and tension control.

A number of temper and skin-pass mills have been revamped to obtain higher operating speeds and thereby higher production. Two of these mills have been run as high as 3,300 fpm with the same ease as 1,000 fpm a few years ago.

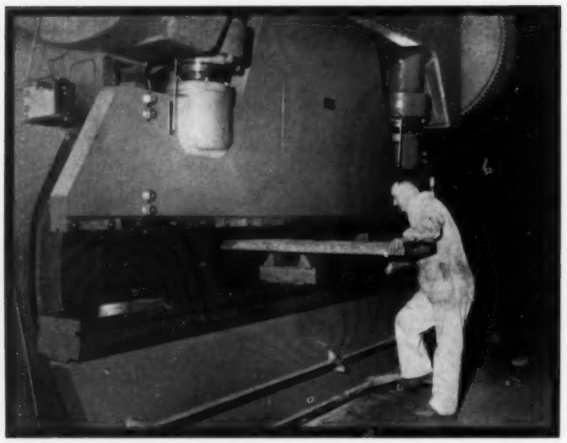
There has been notable activity in rod mills, and it is interesting to note that the trend is to the continuous type with individual driving motors for the various stands. One mill now under construction will be driven by nine motors aggregating 7,650 hp, and another by eleven motors totaling 9,350 hp. In the design of these motors, particular attention has been given to reduce to a minimum impact-speed drop and over-shooting in speed on recovery. One producer has completed the installation of a second group of finishing stands to an existing mill, doubling the previous capacity. Another producer has announced plans for rehabilitation, consolidation, and expansion of wire capacity, to include a new coarse rod mill and new heat treating equipment, in addition to a general overhauling of existing finishing equipment. Other programs of modernization and improvement are in progress.

The problem of shearing alloy steel billets is given a new solution by a vertical type hot billet shear, a self-contained unit readily inserted into a production line. It cuts downward, across the diagonal, and there is therefore less deformation of the billet stock. Complete control from one central point permits one man to operate the shear and runout table, as well as the crop discharge.

Shell forging has proceeded along the general lines indicated in this review last year. Numerous ideas have been applied leading to increased production from these units. General developments point toward the reduction of scrap resulting from the processes and a reduction in the machine work required for finishing. The oldest and most commonly used method of piercing and drawing shell forgings is on hydraulic presses, and this method is perhaps the most suitable for shells larger than 6 in., although applicable to all sizes. A square billet can readily be used, and speeds should be about 14 in. per sec for piercing and 20 in. per sec for drawing. Press sizes range from 200 tons for 3 in. shells to 1,500 tons for 12 in. shells for piercing, and from 75 tons for 3 in. shells to 340 tons for 12 in. shells for drawing. Modern designs of hydraulic piercing presses include the turret type, which pierces blanks for subsequent drawing and the "one-shot" press, which in one operation, produces a finished shell forging ready for machining. Both of these presses were described in our report of a year ago.

Shells up to 6 in. may be produced on horizontal forg-

ing or upsetting machines, driven by electric motors. In these machines, the crosshead carries fine punches, the first for upsetting the steel bar and the other four for piercing and expanding the forging. Thus, five strokes of the machine perform five progressive operations. Other designs require fewer strokes, one accomplishing the piercing operation in a single press stroke, while the forging is simultaneously being drawn through the draw rings. Improved designs of motor-driven horizontal bulldozers are in use for making 75 mm shell forgings. A combination, mentioned last year, which is finding increased use, is that of a hydraulic press or a mechanical upsetter for piercing the billet, which is then reduced in the three-cross-roll Assel mill.



A great number of straightening presses have been installed during 1941, largely in connection with the processing of armor plate material.

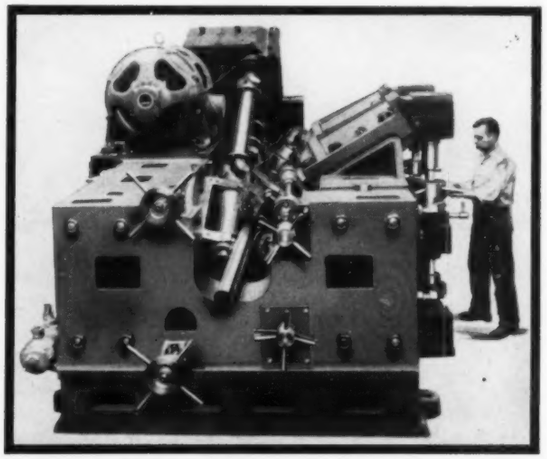
Production rates of the various units vary quite widely. Hydraulic piercing and drawing presses show about 210 shells, 75 mm per hr, and 150-160 shells, 105 and 155 mm, per hr. The turret type press, which must be followed by drawing operations, is stated to pierce 275 75 mm shells with 200-tons press capacity, 250 90 mm shells with 270-tons press capacity, 225 105 mm shells with a 320-ton press, and 200 155 mm shells on a 400-ton press. Upsetters with five punches will produce 65-75 shells, 75 mm per hr, while the combination two-operation unit turns out about 159 105 mm shells per hr. Bulldozers average 160 75 mm shells per hr. The Assel mill will perform the second reduction operation on 75 mm shells at a rate of 235-250 per hr.

Production methods for shells have changed since the last war, specifications now calling for finished forged cavities, with no machining. Likewise, machining has been reduced on the outside of the shell, where only about $\frac{1}{16}$ in. of metal is removed on a side, and only small cuts are made on the nose and the base of the shell.

Differing materially from the high-explosive shells, the solid armor-piercing shell is forged from round bar stock, the diameter of which is approximately two-thirds of the forged diameter of the shell. The nose of the shell is formed by a series of necking operations in the grip of the forging machine, giving proper grain structure in the nose. The body of the shell is shortened by upsetting, further increasing density of the grain structure.

The necessity for straightening armor plate after heat-treating has called for a considerable amount of straightening equipment. Bending presses have presented a speedy, economical method for performing this work. One press of this type is capable of straightening armor plate $2\frac{1}{2}$ in. thick and having a tensile strength of 170,000 psi. Tremendous power is required, as the ram of the press hits at full tonnage capacity every stroke of the machine. One hundred or more strokes are required, depending on plate condition, and the presses run at 20-40 strokes per min, depending upon plate thickness. In the modern presses, there is a trend toward locating all shafting at the rear of the machine, away from possibility of damage by crane or plate. The presses are provided with wide bed top and ram bottom to accomodate wide dies, and the rams may readily be adjusted as much as 6 in. to accomodate various dies.

Some of the larger presses are equipped with individual overhead traveling cranes, simplifying the handling of heavy plate—in and out of the machine, as well as supporting it during press operation. These cranes are mounted on top of the machines with runways extending about 8 ft in front. The crane bridge and carrier are hand propelled, while the hoist is motor driven, controlled by a pendant push button.



Development of this guideless straightening machine is an example of the improvements made in all types of auxiliary equipment.

One newcomer in the field of light armor plate has installed equipment for heat treating, cutting, finishing, and shaping this product. Buildings totaling 300,000 sq ft of floor space have been devoted to this use in this plant, and 18 new furnaces were installed to supplement existing furnaces. Straightening presses and oxy-acetylene cutting equipment complete the installation. About 7,000 tons of plate are produced per month, some

of which is processed by the fabricator. Similar installations have been installed by other producers.

One development for handling and manipulating forgings under the steam hammer or press is called the auto-floor manipulator. This machine which is built in various sizes, travels about as an independent unit under its own power, and can work freely at any point around the furnace, press, or hammer. All motions except floor travel are hydraulic: tilting or raising of peel, opening and closing of tongs, rotation of tong head, and steering. Hydraulic motions are actuated by a motor-driven oil pump. Tractor motion is also derived from an electric motor. Power for both motors is received from a flexible cable attached to a rotating collector mounted at the top of a collector mast.

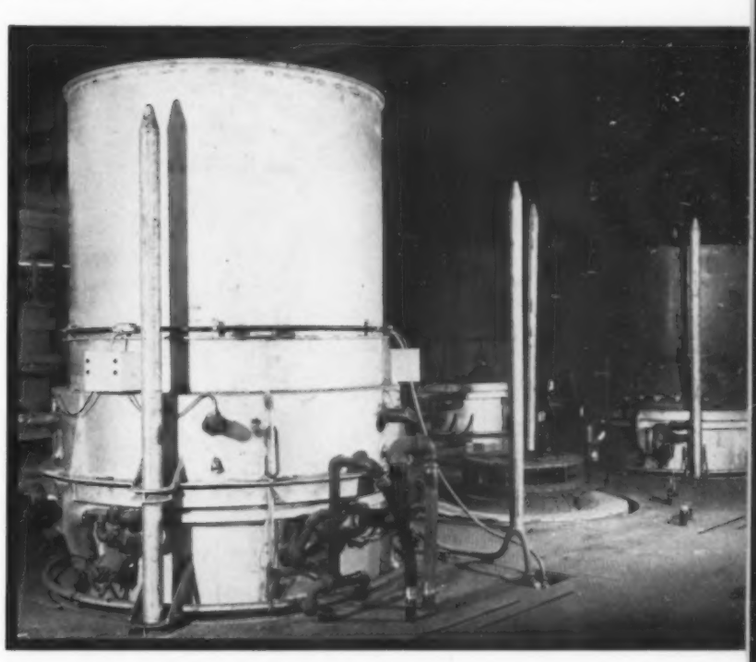
FURNACES AND INSTRUMENTS

Perhaps the most significant thing in the heating furnace field is the activity in soaking pit construction. Long recognized as out-moded and as a source of considerable quality complaints, many of the old-style pits are being replaced. The major part of the new pits are of the one-way firing type, some being fired through the bottom, others through one end-wall. In many cases, the new pits are able to hold considerably more steel, although installed in the same space occupied by the old, smaller pits. It is generally accepted that improved ingot heating will do much to eliminate surface defects in the products.

An improved design of suspended soaking pit cover uses a side shoe tile, which is a refractory shape under the lower leg of the steel channel. This tile protects the steel channel from over-heating and prevents the steel supporting frame from warping. This tile also increases the refractory lap over the pit walls. The sand seal side shoe is a one-piece casting with sufficient surface exposure to render it self-cooling, and overlaps the structural frame and can be attached by two rows of bolts subjected to shear instead of tension. After four years of service, the steel frames of this type of cover were in perfect condition except for some deterioration on the lower edge which cuts into the sand. Heat resisting alloy inserts are now cast into the malleable side shoe to give increased life.

Defense projects have accelerated the furnace business to a tempo not experienced for many years, and in many cases have required the expansion of furnace builders' facilities. Much of this new business entails furnaces of somewhat different design than required for peace time projects. Armor plate finishing has required many furnaces of the car type. In the early part of the year, a battery of new-type furnaces was placed in operation in one of the leading steel mills, for quenching and drawing heats of homogeneous armor plate. The furnaces are of the car-bottom type, and utilize fan circulation to secure maximum temperature uniformity at the drawing temperatures. They have a production between three and four times that of older types of furnaces on draw heats. In another steel mill, the first continuous furnace line for heat treatment of heavy armor plate was placed in operation. This installation consisted of ten roller hearth furnaces. After installation was started, the designs were modified to double the rated capacity of the equipment. It has been demonstrated that the time required to carburize armor plate can be substantially reduced by the use of gas instead of compound as the carburizing medium. Considerable research was conducted during 1941 in this connection.

As the quantities of rifle clip strip and bullet core rod on order increased greatly, other design changes were necessary. Bell type furnaces were produced in much larger units to handle larger charges of identical material, far beyond the usual peace-time tonnages. The problem was to anneal larger single charges without loss of quality, and this has been solved by the construction of furnaces with a number of recirculating fan bases in a single row in a rectangular base unit. Furnaces of this type had been built for tin plate annealing for four stacks of tin plate, so a quick adaptation of design was made to have four to seven stacks of material in a row with oil sealed bases and furnaces made tight for use with an atmosphere with or without an inner cover. Some furnaces of this type for very high carbon steels were provided with alloy base covers, a particularly difficult design for rectangular base construction, but one which has been particularly successful.



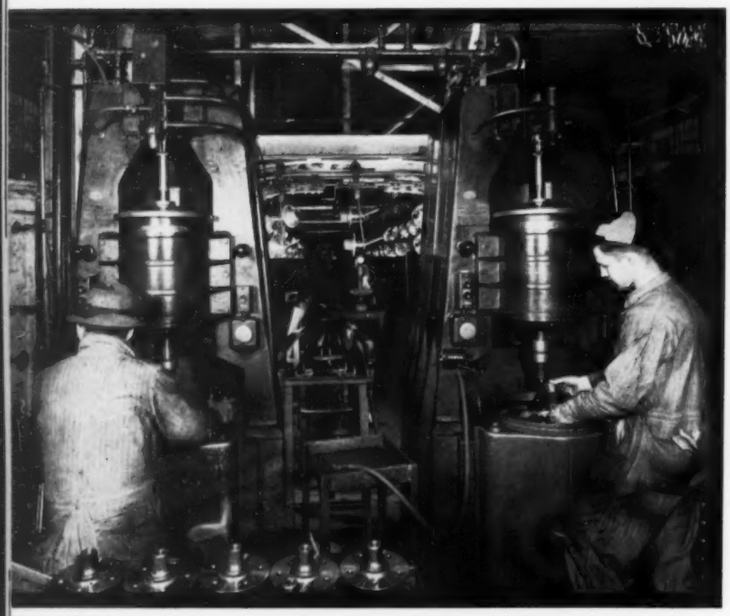
The use of radiant tube annealing furnaces in which the tubes are placed within the inner cover has shown pronounced growth during 1941.

The tendency for increase in size, charge weight, and piling height has been apparent, but it is now felt that a practical limit has been reached in strip or tin plate stacking of 106 in. without endangering the quality of the bottom coils or the safety of the operating personnel.

Our report of a year ago announced two installations of a new design of bell-type radiant tube annealing

furnace, in which the firing tubes are placed within the inner cover, releasing their radiant energy directly to the charge. Anticipated economies and efficiencies of this type of bell furnace were realized, low carbon strip and wire being consistently annealed at fuel rates of 900,000 Btu per net ton of charge. Production is increased over identical size units of the older design by 15-20 per cent. A considerable number of installations of the new type were made during the past year.

An initial installtion of radiant tube fired continuous furnace for tin plate annealing has been made. This unit was described last year. The results obtained have been good and are considered satisfactory for 40 per cent of the present annealing requirements of the tin plate industry. Continued development along this line is indicated.



Induction heat treating machines are used in production lines and give fast, accurate heating over controlled areas.

Radiant tube heating has been applied to conveyor belt bright hardening units for aircraft bolts, rifle clips, etc. Complete continuous units, for shell hardening, quenching and drawing, have been installed. Decided improvement has been made in the use and application of furnace atmosphere for all types of ferrous and nonferrous annealing, perfecting this equipment on the basis of past experience. Particular progress has been made in the field of tool steel and alloy bar annealing in lengths over 30 ft in bell-type furnaces. Usually this material is so brittle as to require annealing before pickling, and thus complete neutral atmospheres are required. Structurally, these furnace units require special design to keep them rigid for handling and are usually too heavy for plant cranes. Superstructures with special hoisting apparatus to lift the furnace are designed as part of the installation.

An advance in protective atmospheres, for such operations as scale-free hardening, bright annealing, sintering, and electric furnace brazing of high carbon steels in which decarburization is not permissible, has been announced. The gas may be generated from various hydrocarbon gases, and the gas and air pass through visual flowmeters, an automatic proportioner, a compressor and pressure regulator, and on through a firecheck to the burners in the reaction chamber. A hopper at the top of the chamber stores charcoal, which is fed through a vertical retort, where it is heated to incandescence. Gases from the combustion chamber, after passing through a surface-type cooler and perhaps an activated-alumina dryer, travel through the incandescent charcoal, where any carbon dioxide and water vapor are converted to carbon monoxide and hydrogen. Filtration then removes any charcoal dust which might be present.

The handling of cylindrical inner annealing covers has been facilitated by a new automatic tong design. Being fully automatic, no ground man is required to place slings or hooks on the hot covers. The tongs are merely lowered on to the top of the covers and automatically take a three-point hold. Lifting capacities run as high as 200,000 lb.

The restricted nickel supply has produced complications for the manufacturers of heat-resisting alloys and has precipitated a great amount of development work. One line of investigation attempted to conserve nickel by lengthening the life of these alloys at high temperatures, in the range from 1,500 F and up. Some of the more difficult applications have to do with oil quenching of trays and baskets from carburizing temperatures and for holding the molten neutral salts at heat treating temperatures of 1,650 F. These were outstanding cases where improvement in life of the alloy would conserve nickel and release facilities for defense use. It appeared very much that failures in these applications could be attributed to grain growth in the alloys and, or carbide precipitation in the grain boundaries tending to weaken the cohesion of the metal. Tests and investigations finally disclosed proper alloy additions which, when added to these high nickel alloys, would accomplish the desired effects. It was known, also, that the attainment of these major objectives would at the same time vastly improve the cold and hot strength.

The first tests, both laboratory and in service, confirmed the theory. The resistance to creep at 1,800 F was increased fifty fold. The resistance to the disruptive effect of quenching mentioned above appears to be doubled as likewise the life of pots and containers for the corrosive neutral salts. Efforts are now being made to translate these findings to commercial practice and standardize on these alloy additions for regular production.

Coincidental with these studies, an investigation was made of the possibilities of using lower nickel content alloys in any given application. The three most usual analyses of these heat resisting castings are as follows:

(1) Type NC-2: 60 per cent Ni, 13 per cent Cr, balance Fe.
(2) Type NC-4: 35 per cent Ni, 15 per cent Cr, balance Fe.
(3) Type CN-36: 21 per cent Ni, 28 per cent Cr, balance Fe.

The study showed that very little, if any, change could

be made in the applications. It developed that where any appreciable use was being made of the NC-2 alloy, the user was thoroughly conversant with the availability of the lower alloys, particularly the saving in first cost, and had tried in every way to use it, without success.

The attempted substitution of the lower nickel content alloy has resulted in:

(1) Susceptibility to carburization.
(2) Failure under heat shock.
(3) Comparatively early failure of parts difficult to install, involving costly shut-downs of important operations.
(4) Breakdown of parts on which expensive machining operations had been performed.

It is reasonable to expect that some substitutions can be made on individual study of the application, but in the major uses it seems apparent that delays and expense would occur, and additional nickel and foundry capacity would be required if any thoughtless substitutions were made.

Insulating fire brick, produced from a plastic refractory clay and an organic filler, are now furnished for direct exposure in a wide variety of heating equipment at temperatures up to 2,600 F. The burning out of the organic filler during the manufacturing process leaves a uniform controlled pore structure, imparting characteristics of light weight, strength, and high insulating value.

Castable light-weight insulating refractories are also available, suitable for service at temperatures as high as 2,200 F. It is especially suitable for lining furnaces used for heat treating, annealing, stress relief, and carburizing, and for lining ducts, breechings, etc. The material weighs 57 lb per cu ft and sets in 12-24 hr with a compressive strength of 1,485 psi. Thermal conductivity, in Btu per sq in. per in. of thickness per hr per degree F, is 1.80, 2.15, and 2.35 at mean temperatures of 400, 800, and 1,200 F, respectively. Heat storage is said to be 60 per cent lower than that of fire brick.

Many furnaces have been changed over from natural gas to fuel oil, in expectation of a shortage of the former. Plants have installed or extended fuel oil systems, and the increased use of this fuel is reflected in volume of oil burners sold. Oil burners in general show improved design, tending toward simplification, greater turndown range and better proportioning.

High-frequency induction heating has made much progress, particularly in the armament field, where control of heat penetration and heated areas is paramount. A considerable amount of this equipment has been used in connection with heating bars intended for forging into 75 mm and 105 mm shells. Typical of these installations is one including five 400 kw, 1,920 cycle motor-generator sets operating 25 heaters, and three 600 kw sets operating 18 heaters. Such installations for heating shell tubes prior to nosing, and for spinning bombs, give rapid heating, lower scale formation, few rejects, and are said to have a high peace-time salvage value. Other installations use other frequencies, ranging from 1,000 cycles up to 9,600 cycles, depending on the purpose for which they are intended, the high values being used principally for surface heat treating rather than thorough heating.

Numerous improvements are reported by manufacturers of combustion controls and instruments, generally resulting in simplification and reduced maintenance. The use of electronic tubes in the design of temperature measuring and control equipment is growing. In one type of recording pyrometer, the conventional galvanometer is replaced by an electronic convertor and amplifier. Thus, any unbalance between the thermocouple and the slide wire voltages, as caused by temperature change of the thermocouple, is converted into an alternating voltage and greatly amplified. The phase of the alternating voltage depends on the direction of the potentiometer unbalance, and determines the direction of rotation of the balancing motor. This design should well withstand conditions of vibration, temperature, and atmosphere found in the steel plant.

Equipment, consisting of a radiant thermocouple, a ceramic sighting tube and a shield, has been developed to make possible accurate measurement of work temperature. Errors due to flame, smoke and reflected radiation do not affect the measurement. Furnace temperatures vary up and down as needed to keep the work temperature constant. This method of control is particularly valuable where mill activity causes a fluctuating demand. Furnace temperature may vary from the desired temperature of the work to four or five hundred degrees above work temperature, but with this type of control each piece is discharged at the correct temperature.

Similar equipment is used to detect actual checker brick temperatures in blast furnace stoves, replacing the thermocouple method of measuring gas temperatures and computing checker brick temperatures. Experience has shown that the assumed relation between gas and checker temperature is actually subject to considerable variation and causes inaccuracy when used as a basis of computation. Thus, maximum economy, dependent upon reversal of the heating-up and blast cycles at optimum checker brick temperatures, demands accurate checker brick temperature measurements.

This accuracy is obtained by equipment consisting of a radiant couple mounted above the stove top plate and attached by pipe to a 3½ x 40 in. chrome alloy open-end tube which extends down through the inside stopper block. Air is introduced into the upper end of the pipe to keep it clear of dust and fumes and to prevent the lens from clouding. A valve, installed in the piping below the head of the radiant couple, can be closed so that the head can be removed at any time for inspection without affecting the stove pressure.

A convenient accessory on multiple thermocouple installations is an automatic temperature indicator, which permits reading of one of a number of thermocouples up to fifty from one instrument by merely throwing a toggle switch. This action connects instrument into thermocouple circuit and automatically moves pointer to correct scale position.

A new time-temerpature controller, recently designed and patented, promises to replace present methods of obtaining control of the rate of heat increase or decrease in industrial heating processes. The unit includes two adjustments; namely, rate of increase or decrease in degrees per hr, and number of hours during which this

rate is to be maintained. When installed in a temperature control system including any standard type of pyrometer and fuel regulator, control is completely automatic and at the end of the preset time, the temperature must be at the desired point. Heating and cooling processes can be controlled with equal ease, providing straight-line rates of increase or decrease. The controller may be superimposed upon any type of control system.

Several installations have been made of a newly developed low cost semi-continuous pickling line of limited capacity.

PROCESSING AND MATERIAL HANDLING

Numerous finishing and processing units were installed, and many others modernized and speeded up during 1941. Many of the year's developments are the direct result of the national defense program. Armor plate production has called for much equipment, one example of this being the heavy duty backed-up roller leveler for leveling plate up to one inch thick.

One of the interesting developments of the year with respect to processing and finishing equipment has been the installation of multiple purpose lines designed to perform different operations, or to handle material of widely varying specifications. One example of this is a combination slitting and shearing line consisting of a coil holder, slitter, reel, flying shear, belt conveyor, and piler, arranged to receive materials in coils and either slit it into multiple widths and recoil, or shear it into cut lengths and pile. In the latter case the material may be side-trimmed before shearing, the slitter used being a conventional side-trimmer with removale slitting arbors.

A large number of slitting lines for slitting wide strip into multiple widths have been installed during the past year. In this connection, production requirements have often made it desirable to slit both light and heavy gauge strip on the same line, a difficult problem since light gauges are best slit by relatively small diameter knives, while for heavy gauges larger arbors and, therefore, larger diameter knives are required. This problem has been solved by the use of a combination slitting unit.

The unit has a main base on which the drive with universal spindle connection to the arbors is permanently mounted. This base is designed to receive either of two slitting assemblies, each consisting of portable base, housings, arbors, and knives. For example, one installation has an assembly with 10-in. diameter knives for slitting light gauge strip, and another assembly with larger diameter arbors and 15 in. diameter knives for slitting heavier material. While one slitting assembly is in use, the knives on the other slitting assembly can be packed for the next order.

Several plants have installed strip cleaning and tight coiling lines for cleaning light gauge strip before annealing. The cleaning units consist of alkali spray and scrubber unit, incorporating large capacity pressure sprays and separately driven high-speed brushes above and below the strip, followed by a similar water spray and scrubber unit. A special feature of one of these lines is that the ends of the coils are not joined together, eliminating the use of a welder or stitcher at the entry end and the use of a shear at the exit end. The line, which operates at a speed of 800 fpm, consists of a cone-type coil holder, alkali spray and scrubber unit, water spray and scrubber unit, dryer, pinch rolls, tension bridle and recoiler. The leading end of each coil is fed through the cleaner unit by a series of motor-driven pinch rolls, which are disconnected by magnetic clutches after the material reaches the main pinch rolls.

The demand for larger coils having smaller inside diameters has resulted in considerable development work with respect both to tension reels and expanding mandrel type uncoilers. In both bases, mechanically and hydraulically operated types are now available for handling 16 in. diameter coils weighing 15,000 lb or more and 20 in. diameter coils up to 30,000 lb. There seems to be a distinct trend towards the use of hydraulic operation for the various auxiliary movements of machines of this type.

A new type tension reel was developed, of three segment type, centered by a large core shaft on which are massive eccentrics for expanding or collapsing the segments through means of a wedge closure. All pressure contacts are designed for rolling friction that a minimum effort is necessary for collapsing the reel. The reel is collapsed or expanded by a 180 degree rotation of the drum effectively handled through a gear reduction unit and a brake. It is positively locked in the expanded position. A belt wrapper winds the strip from the mill onto the reel. Automatic adjustable tension is provided by means of a variable speed drive and constant tension sheave, driven directly from the mill gear reduction drive.

A low cost semi-continuous strip pickling line has been developed, designed for a capacity of 10,000-12,000 tons per month. One installation of this type handles two strips simultaneously, of 22½ in. maximum width, .06-.25 in. thick, at a nominal speed of 85 fpm. Hot rolled strip is entered through pinch rolls and

passes through a multi-roll leveler and a set of steel brush rollers. Guides then lead the strip into the first acid tank, which is 45 ft long. The second acid tank is 90 ft long. Both tanks are about 12 in. in depth, and are of acid-resisting construction, lined with hard-burned tile. The tank bottoms are given a degree of concavity, so that the strip is supported only on its two edges by the tile bottom. Each strip is pushed through the tanks by pinch rolls, so that no form of joining the strips is required. A cold water rinse tank, a hot water rinse tank, a hot air dryer, and a three-roll type coiler follow to complete the line.

The acid tanks hold a comparatively small amount of solution. A storage tank is therefore provided, equipped with lead heating coils through which steam is circulated. Thus, there is no dilution of the solution by the steam used for heating. A motor-driven, acid-proof pump maintains a constant return flow of pickling solution from the storage tank to the pickling tanks, giving a certain amount of agitation which aids the pickling action.

Submerged combustion has received wider application, and is now operating in the pickling of wire, bars, sheets and tubes. Burners of this type range 250,000-1,500,000 Btu per hr in capacity, and experimental designs of 10,000,000-50,000,000 Btu per hr capacity are being tested for evaporating and water purification purposes. The metal used in these burners has been made more acid resistant than previously and will operate in sulphuric or hydrochloric acids for a year or more. With special precautions, the equipment may be used with mixtures of nitric and hydrofluoric acids. The burners will operate on any type of gas without major change.

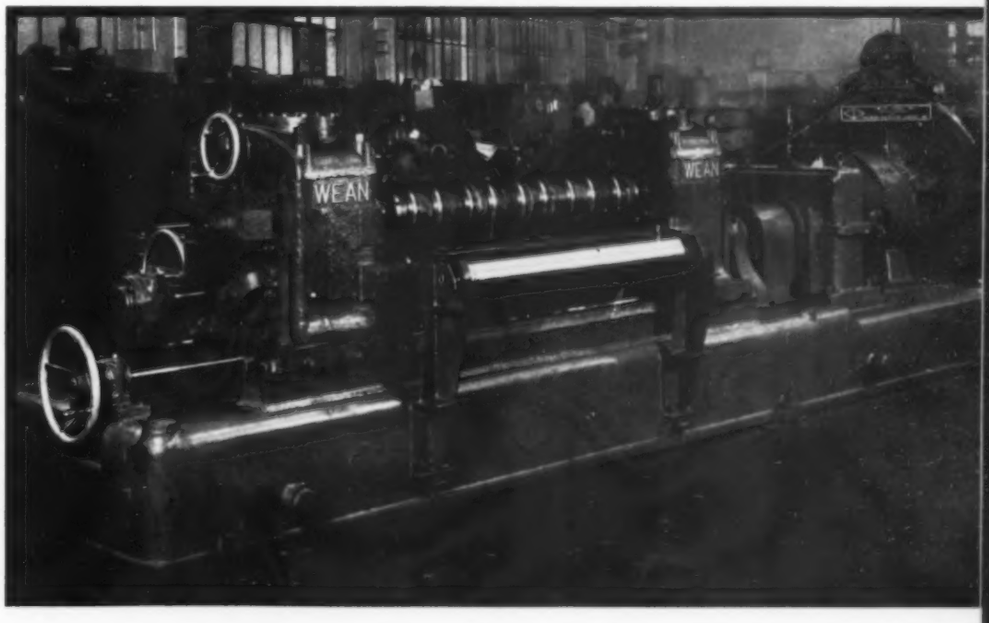
Electrical immersion heating of acid solutions, electroplating solutions, etc., may be effected by a unit consisting of a standard immersion heater enclosed in a lead-coated tubular leg, with a second leg enclosing the sensitive bulb of a thermostat. The control temperature may be set by means of an adjusting knob, and the unit is available in various sizes and ratings.

In the wire-drawing field there has been exceptional activity, and a great many units have been built, with more under construction. Variable voltage control has been applied to multi-motor wire blocks, giving smooth, flexible acceleration and deceleration, and allowing the use of higher power for faster drawing speeds. Considerable work has been done on the application of back tension on the wire in the machine. Tensiometers can be applied to measure these tensions, and indications point to some interesting results along this line. Power used to drive some of the new wire drawing machines is supplied from new 250 volt rectifier installations.

A great number of draw-bench installations were made during 1941, some of these using torque—continuity control for smooth acceleration of multi-speed induction motors. A contact-making wattmeter with adjustable contacts has been developed to give more accurate indication of slippage of the clamp and completion of the draw.

Tin has become a highly strategic metal, with the steel industry requiring perhaps 80,000,000 lb per year for the production of tinplate. The potential saving of tin offered by the electro-plating method of production has long been recognized, and much development work has been expended on it, culminating in several trial installations. The industry has watched the work in this line, and at the close of 1941 orders were placed for several electro-tinning units.

In a paper before the A. I. S. E. 1941 Annual Convention, M. D. Stone discussed the problem of electro-tinning of steel strip. A pilot installation has shown the process to be a practical commercial process. It has been demonstrated that lighter coated tinplate can be produced, saving about two-thirds of the tin required by the hot dip process, and, under certain conditions, comparing favorably in coversion cost as well. The use of high current densities (300-500 or more amp per sq ft of strip) have allowed higher speeds of operation, ranging up to 500 fpm. Acid electrolyte, such as tin sulphate seems preferable. The dull gray surface produced by this process can be brightened by mechanical

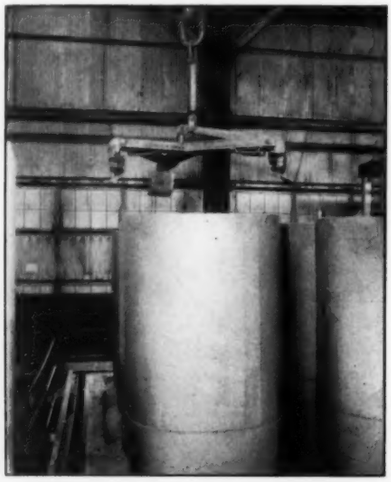


The use of interchangeable slitting assemblies, with different sizes of knives, gives this slitting unit great flexibility of operation over a wide range of gauges.

brushing and buffing, by thermal reflowing of the deposited tin, or by electrolytic brightening, with the first two methods apparently more practical.

Much work is also being done in an effort to develop other types of coatings which may be used as a substitute for tin.

It has been estimated that the country's zinc supply in 1942 will be about 989,000 tons, with a consumption



A wide range of special tongs are available for special lifting jobs, and offer speedier, safer operation.

projected at 1,019,000 tons. It is felt that, with care, and possibly some substitution and diversion of steel, all requirements will be met. New producing units should in the next year raise production to an adequate level unless export demands should increase to a great extent.

The effect of armament production is noticeable on material handling equipment. A large number of chain type car hauls were built for propelling cars of armor plate to and from heat treating furnaces. The manufacture of shells and bombs requires many special conveyors through the process. Likewise, many conveyors were required for heat treating furnaces, quenching and drawing operations.

Outwardly, there has been little change in the design or appearance of industrial trucks. There were, however, many minor changes in design tending to improve operation and reduce maintenance. The advantages of full contactor control are now available to heavy duty industrial trucks. One manufacturer has equipped a 10,000 lb fork and ram unit with control apparatus of the same design as used in transportation service. Control of this type is ruggedly built to withstand severe usage, and years of service have proven its applicability to heavy duty trucks. Contactors, of the single unit type, are identical on the various motions, and are mounted on the panel as individual units. The automatic acceleration afforded by this system should result in long life and reduced maintenance on equipment of this type.

Recently introduced, lifting magnets 77 in. in diameter were found to lift about twice the material lifted by the 65 in. magnet.

ELECTRICAL DEVELOPMENTS

The A. I. S. E. research program on crane bridge girder design was completed in 1941. This work, which was carried out by I. E. Madsen at Lehigh University in cooperation with the committee on crane specifications, was sponsored and financed by the Association. Reports of these investigations were published in the Iron and Steel Engineer for November, 1941, and the results derived from them will be incorporated in the revised crane specifications which should be available in 1942.

A new type main circuit crane safety limit stop to prevent overtravel of the crane hook when hoisting is of interest. This device operates by means of a counter weighted lever and a suspended reset weight. As the hook approaches its limit of travel the reset weight is raised, thus allowing the counter weight to trip the switch. A quick make and break mechanism opens the normally closed power contacts to disconnect the motor from the line and closes another set of contacts to connect a resistor across the motor circuit establishing smooth, quick, dynamic braking. Taps are provided in the resistor to adjust the braking in accordance with the service condition. When the limit stop is in the tripped position, a by-pass circuit is established which permits backing out of the limit at slow speed.

A new high was reached in sizes of lifting magnets with the introduction of a 77 in. magnet. It has been found that this magnet lifts approximately twice the amount of material lifted by a 65 in. magnet, and therefore effects a marked reduction in the time for handling a given amount of material.

Scanning the activity in the electric motor field, we find many unusual items, due to the nature of the service to be met. For example, an 1,800 rpm, 3,000 hp squirrel cage polyphase induction motor and a 3,600 rpm, 1,500 hp two-pole sound rotor polyphase induction were built, both believed to be the largest of their respective types. At the other end of the scale, a 35 hp, 18,000 rpm motor was built into a frame of 4 in.

diameter and 10 in. length. This is intended for work in aeronautical research. Of similar type, a 200 hp, 5,000 rpm motor was only 10 in. x 31 in., and a 1,000 hp, 2,400 rpm unit was 28 in. x 39 in.

Machine tool motors were in great demand. A new sturdy fractional-horsepower motor was designed particularly for this service. It is totally enclosed, of three-phase construction, and equipped with ball bearings. Many other special fractional-horsepower motors were developed during the year. Mechanized defense equipment calls for innumerable shapes and types of small motors, most of them of special design. Thus, small motors for aircraft range from 1/200 hp, continuous, at 7,500 rpm to 7 hp, one minute intermittent duty, 7,500 rpm, and are available in the following types: open, totally enclosed, totally enclosed fan-cooled, and, where necessary, explosion proof. These aircraft motors are built with aluminum or magnesium castings for light weight.

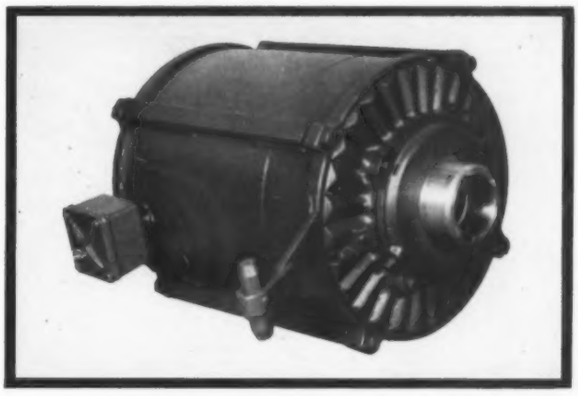
As an answer to an increasing and widespread demand for greater protection in open, general-purpose motors, one maufacturer announced an entire new line of polyphase induction motors in integral horsepower sizes. Built to conform with new industrial trends and practices, the motors feature modern streamlined appearance; more complete protection than heretofore available except in specially enclosed machines; major advances in insulation of current carrying parts; and improved bearing design and lubrication provisions. A cast aluminum rotor and a pressure-relief system of greasing are also featured. Extra protection is obtained through the use of a cast iron frame of box type, with end-shields designed to match the frame and enclosed above the center line. Integrally cast rotor fans and improved design of air passages and baffles contribute materially to the solution of the ventilation problem. Thermal capacity of the motor was improved. The use of tough heat- and solvent-resisting magnet wire has almost eliminated fibrous insulating materials, and the windings are furthr protected by an improved synthetic resin varnish. This line of motors has also been supplemented by a line of splash-proof motors, in which the ventilating openings of the stator frame and end-shields are carefully baffled to block the entrance of splashing liquids.

The Iron and Steel Engineer for August, 1941, carried a description of a floating motor drive for mill tables. In this design the rotor is mounted on a sleeve which in turn is mounted on and keyed to the shaft extension of the roller. The stator is carried from the rotor sleeve through ball bearings. Rotation of the stator is prevented by a lug which is anchored to the table bed by two coil springs. Available either in a-c or d-c, these motors are not affected even though table rollers are warped or not level.

A comparatively new development which is receiving wider application is a magnetic variable speed drive, providing adjustable, wide range speed changes in conjunction with constant speed motors. The unit consists of two torque elements—an outer flux-linkage ring and an inner flux-producing magnet free to rotate. Adjustment of a small exciting current supplied to the magnet changes the flux and, consequently, the relative speed of magnet to ring. Thus, the speed of the driven load may be varied easily and with great precision.

The accompanying motor lists indicate that many large main drive motors were also installed during 1941. The proportion of these going into the non-ferrous metal industry this year is significant and indicates the expansion in this direction. Of interest is the continued trend to higher power on rolling mills.

Industrial expansion requires power, and orders placed by public utilities and industries for power generating equipment represent a record-breaking total kw capacity. Here the trend toward the higher steam pressures and temperatures is apparent, with a number of units designed for 1,200-1,350 lb pressure and temperatures as high as 950 F. The use of hydrogen cooling in generators seems to be increasing. Mobile steam-electric power plants, of 10,000 kw capacity, are being mounted on special railway cars. These are intended to supply emergency power wherever required. The boiler and its auxiliaries and a starting engine generating set will have one car. The turbo-generator switchgear will have a second car. A mobile substation will also be mounted on a standard car so that proper voltage may be available. In another case, a transformer bank was mounted on a motor truck, the mobile unit being intended for emergency service.



The floating motor drive for mill table rollers simplifies table construction and is not affected by warped or out-of-level rollers.

With the increased loads resulting from plant expansions, many cases have been found where the existing power distribution circuits become overloaded. Some of these cases have been solved by the installation of power factor corrective equipment, reducing current flow in the conductors and, at the same time, freeing generator capacity. Several reports show where capacitors have paid for themselves in 12-15 months. Small capacitors may now be combined with switches, so that the correction is distributed through the plant in the same manner as the power load.

The great expansion of electric arc furnace capacity has imposed rather severe requirements upon some of the power systems which supply these furnaces. The type of electric load imposed by arc furnaces brings several problems, not the least of which is the flicker problem. Due to the fact that arc furnace loads may

ELECTRIC MOTORS OVER 300 HORSEPOWER

Applied to Main Roll Drives in the Iron and Steel and Allied Industries during the year 1941

Horse-power	Revolutions per minute	Volts	Fre-quency	Method of drive	Kind of mill	Purchaser	Location	Manufacturer
300	300/600	600	d-c.	Geared	Entry tension rolls	Tennessee Coal, Iron and R.R. Company	Fairfield, Alabama	Allis-Chalmers
300	300/1050	333	d-c.	Geared	80 in. skin pass reel	American Rolling Mill Company	Middletown, Ohio	Westinghouse
300	300/600	600	d-c.	Direct	2-stand temper mill	Republic Steel Corporation	Niles, Ohio	General Electric
300	400/1200	600	d-c.	Geared	Stecked mill	Cold Metal Products Company	Youngstown, Ohio	Crocker-Wheeler
350	200/650	600	d-c.	Geared	Coarse rod mill	American Steel and Wire Company	Joliet, Illinois	General Electric
350	600/1200	250	d-c.	Geared	Brass strip mill	American Brass Company	Kenosha, Wisconsin	Westinghouse
350	600/1200	250	d-c.	Geared	Brass strip mill	American Brass Company	Kenosha, Wisconsin	Westinghouse
350	180/360	250	d-c.	Direct	20 in. skin pass mill	Republic Steel Corporation	Warren, Ohio	Allis-Chalmers
350	225/450	700	d-c.	Direct	10 in. merchant mill	Allegheny-Ludlum Steel Corporation	Dunkirk, New York	Allis-Chalmers
400	300/1050	333	d-c.	Geared	54 in. skin pass reel	American Rolling Mill Company	Middletown, Ohio	Westinghouse
400	400/800	700	d-c.	Geared	10 in. mill train	Allegheny-Ludlum Steel Corporation	Dunkirk, New York	General Electric
400	400/800	700	d-c.	Geared	10 in. mill train	Allegheny-Ludlum Steel Corporation	Dunkirk, New York	General Electric
400	400/800	700	d-c.	Geared	8 in. mill train	Allegheny-Ludlum Steel Corporation	Dunkirk, New York	General Electric
400	514	2200	60*	Geared	Cold breakdown mill	American Brass Company	Kenosha, Wisconsin	General Electric
400	514	2200	60*	Geared	Cold breakdown mill	American Brass Company	Kenosha, Wisconsin	General Electric
400	250/750	600	d-c.	Geared	Rod and merchant mill	Columbia Steel Company	Pittsburg, California	General Electric
400	250/750	600	d-c.	Geared	Rod and merchant mill	Columbia Steel Company	Pittsburg, California	General Electric
400	720	4600	60†	Geared	Cold strip mill	Chase Brass and Copper Company	Euclid, Ohio	General Electric
400	720	4600	60†	Geared	Cold strip mill	Chase Brass and Copper Company	Euclid ,Ohio	General Electric
500	300/950	600	d-c.	Geared	Continuous billet mill	Youngstown Sheet and Tube Company	Youngstown, Ohio	Westinghouse
500	300/950	600	d-c.	Geared	Continuous billet mill	Youngstown Sheet and Tube Company	Youngstown, Ohio	Westinghouse
500	500/1000	600	d-c.	Geared	Cold brass mill	Bridgeport Brass Company	Indianapolis, Indiana	Westinghouse
500	250/500	600	d-c.	Direct	2-stand temper mill	Republic Steel Corporation	Niles, Ohio	General Electric
500	250/787	600	d-c.	Geared	Reversing cold mill reels	Sharon Steel Corporation	Sharon, Pennsylvania	General Electric
500	250/787	600	d-c.	Geared	Reversing cold mill reels	Sharon Steel Corporation	Sharon, Pennsylvania	General Electric
500	225/625	600	d-c.	Geared	Rod and merchant mill	Columbia Steel Company	Pittsburg, California	General Electric
500	225/625	600	d-c.	Geared	Rod and merchant mill	Columbia Steel Company	Pittsburg, California	General Electric
500	200/800	600	d-c.	Direct	Coarse rod mill	American Steel and Wire Company	Joliet, Illinois	General Electric
500	200/800	600	d-c.	Direct	Coarse rod mill	American Steel and Wire Company	Joliet, Illinois	General Electric
500	250/750	600	d-c.	Geared	Rod and merchant mill	Columbia Steel Company	Pittsburg, California	General Electric
500/375	250/500	2200	60*	Geared	Brass mill	Scovill Manufacturing Company	Waterbury, Connecticut	General Electric
500	350/620	600	d-c.	Direct	42 in. temper pass mill	Tennessee Coal, Iron and R.R. Company	Fairfield, Alabama	Allis-Chalmers
500	350/650	600	d-c.	Geared	48 in., 2-stand temper mil	Carnegie-Illinois Steel Corporation	Dravosburg, Pennsylvania	Allis-Chalmers
500	400/600	316	d-c.	Geared	Temper pass mill	Tennessee Coal, Iron and R.R. Company	Fairfield, Alabama	Allis-Chalmers
500	400/600	316	d-c.	Geared	Exit tension device	Tennessee Coal, Iron and R.R. Company	Fairfield, Alabama	Allis-Chalmers
600	300/900	600	d-c.	Geared	Steckel mill	Cold Metal Products Company	Youngstown, Ohio	Crocker-Wheeler
600	300/900	600	d-c.	Geared	Steckel mill	Cold Metal Products Company	Youngstown, Ohio	Crocker-Wheeler
600	200/600	600	d-c.	Direct	Coarse rod mill	American Steel and Wire Company	Joliet, Illinois	General Electric
600	200/600	600	d-c.	Direct	Coarse rod mill	American Steel and Wire Company	Joliet, Illinois	General Electric
600	200/400	700	d-c.	Direct	10 in. mill train	Allegheny-Ludlum Steel Corporation	Dunkirk, New York	General Electric
600	200/700	600	d-c.	Geared	Reversing cold mill reels	American Rolling Mill Company	Butler, Pennsylvania	General Electric
600	200/700	600	d-c.	Geared	Reversing cold mill reels	American Rolling Mill Company	Butler, Pennsylvania	General Electric
700	300/600	600	d-c.	Geared	66 in. skin pass mill	Republic Steel Corporation	Monroe, Michigan	Allis-Chalmers
700	500/1130	600	d-c.	Geared	Continuous billet mill	Youngstown Sheet and Tube Company	Youngstown, Ohio	Westinghouse
700	150/525	600	d-c.	Geared	Continuous billet mill	Youngstown Sheet and Tube Company	Youngstown, Ohio	Westinghouse
700	150/525	600	d-c.	Geared	Continuous billet mill	Youngstown Sheet and Tube Company	Youngstown, Ohio	Westinghouse
750	500	2300	50†	Geared	Piercing mill	Phelps Dodge Corporation	Los Angeles, California	General Electric
800	350/600	600	d-c.	Direct	42 in. temper pass mill	Tennessee Coal, Iron and R.R. Company	Fairfield, Alabama	Allis-Chalmers
800	350/600	600	d-c.	Geared	Exit tension rolls	Tennessee Coal, Iron and R.R. Company	Fairfield, Alabama	Allis-Chalmers
800	350/575	600	d-c.	Geared	48 in., 2-stand temper mill	Carnegie-Illinois Steel Corporation	Dravosburg, Pennsylvania	Allis-Chalmers
800	315/515	600	d-c.	Geared	Exit tension device	Carnegie-Illinois Steel Corporation	Dravosburg, Pennsylvania	Allis-Chalmers
800	900	2300	60†	.....	Tube mill	American Manufacturing Co. of Texas	Ft. Worth, Texas	Elec. Mach. Mfg. Co.
800	900	2300	60†	.....	Tube mill	Texas Steel Manufacturing Company	Ft. Worth, Texas	Elec. Mach. Mfg. Co.
800	900	2300	60†	.....	Tube mill	Texas Steel Manufacturing Company	Ft. Worth, Texas	Elec. Mach. Mfg. Co.
800	900	2200	60†	.....	Tube mill	Canonsburg Steel and Iron Works	Canonsburg, Pennsylvania	Elec. Mach. Mfg. Co.
800	900	2200	60†	.....	Tube mill	National Tube Company	Pittsburgh, Pennsylvania	Elec. Mach. Mfg. Co.
800	575/1000	600	d-c.	Geared	Cold brass mill	Bridgeport Brass Company	Indianapolis, Indiana	Westinghouse
800	575/1000	600	d-c.	Geared	Cold brass mill	Bridgeport Brass Company	Indianapolis, Indiana	Westinghouse
800	575/1000	600	60*	Geared	Cold brass mill	Chase Brass and Copper Company	Cleveland, Ohio	Westinghouse
800	575/1000	600	60*	Geared	Cold brass mill	Chase Brass and Copper Company	Cleveland, Ohio	Westinghouse
800	250/750	600	d-c.	Geared	1-stand finishing mill	Western Cartridge Company	East Alton, Illinois	General Electric
800	225/787	600	d-c.	Geared	Reel motor	Reynolds Alloys Company	Lister, Alabama	General Electric
800	225/730	600	d-c.	Geared	Coarse rod mill	American Steel and Wire Company	Joliet, Illinois	General Electric
800	720	2300	60*	Geared	Cold breakdown mill	American Brass Company	Kenosha, Wisconsin	General Electric
800	720	2300	60*	Geared	Cold breakdown mill	American Brass Company	Kenosha, Wisconsin	General Electric
800	720	2300	60*	Geared	Cold breakdown mill	American Brass Company	Kenosha, Wisconsin	General Electric
800	300/900	600	d-c.	Geared	Rod and merchant mill	Columbia Steel Company	Pittsburg, California	General Electric
800	300/900	600	d-c.	Geared	Rod and merchant mill	Columbia Steel Company	Pittsburg, California	General Electric
900	300/810	600	d-c.	Geared	Continuous billet mill	Youngstown Sheet and Tube Company	Youngstown, Ohio	Westinghouse
900	500	600	d-c.	Geared	26 in. x 40 in. reversing mill	American Brass Company	Kenosha, Wisconsin	Allis-Chalmers
900	500	600	d-c.	Geared	26 in. x 40 in. reversing mill	American Brass Company	Kenosha, Wisconsin	Allis-Chalmers
1000	250/750	600	d-c.	Geared	Steckel mill	Amreican Steel and Wire Company	Cleveland, Ohio	Crocker-Wheeler
1000	505	6600	60*	Geared	Brass breakdown mill	Western Cartridge Company	East Alton, Illinois	Westinghouse
1000	250/750	600	d-c.	Geared	2-stand cold mill	Western Cartridge Company	East Alton, Illinois	General Electric
1000	250/750	600	d-c.	Geared	2-stand cold mill	Western Cartridge Company	East Alton, Illinois	General Electric
1000	590	2300	60*	Geared	Cold brass mill	Revere Copper and Brass Company	Chicago, Illinois	Westinghouse
1000	575/862	600	d-c.	Geared	4-high cold brass mill	Revere Copper and Brass Company	Chicago, Illinois	Westinghouse
1000	575/862	600	d-c.	Geared	4-high cold brass mill	Revere Copper and Brass Company	Chicago, Illinois	Westinghouse
1000	590	2300	60*	Geared	Cold brass mill	Revere Copper and Brass Company	Chicago, Illinois	Westinghouse
1000	590	2300	60*	Geared	Cold brass mill	Revere Copper and Brass Company	Chicago, Illinois	Westinghouse
1000	590	2300	60*	Geared	Cold brass mill	Revere Copper and Brass Company	Chicago, Illinois	Westinghouse
1000	585	2200	60*	Geared	Brass breakdown mill	Winchester Repeating Arms Company	New Haven, Connecticut	Westinghouse
1000	250/750	600	d-c.	Geared	Brass rundown mill	Winchester Repeating Arms Company	New Haven, Connecticut	Westinghouse
1000	225/730	600	d-c.	Geared	Coarse rod mill	American Steel and Wire Company	Joliet, Illinois	General Electric
1000	300/375	600	d-c.	Geared	Reversing hot brass mill	Bridgeport Brass Company	Indianapolis, Indiana	General Electric
1000	300/375	600	d-c.	Geared	Reversing hot brass mill	Chase Brass Corporation	Euclid, Ohio	General Electric
1000	300/900	700	d-c.	Geared	3-high roll train	Allegheny-Ludlum Steel Corporation	Dunkirk, New York	General Electric
1250	507	4600	60*	Geared	Cold brass mill	Chase Brass and Copper Company	Cleveland, Ohio	Westinghouse
1250	360	6600	60*	Geared	Skin pass mill	Reynolds Alloys Company	Lister, Alabama	General Electric
1250	600	2300	60*	Geared	Aluminum rolling mill	Aluminum Company of America	New Kensington, Pennsylvania	General Electric
1250	200/630	600	d-c.	Geared	Coarse rod mill	American Steel and Wire Company	Joliet, Illinois	General Electric
1250	200/600	600	d-c.	Geared	Coarse rod mill	American Steel and Wire Company	Joliet, Illinois	General Electric
1250	200/600	600	d-c.	Geared	Coarse rod mill	American Steel and Wire Company	Joliet, Illinois	General Electric
1250	250/500	600	d-c.	Geared	Coarse rod mill	American Steel and Wire Company	Joliet, Illinois	General Electric
1250	360	2300	60*	Geared	Piercing mill	Chase Brass and Copper Company	Waterville, Connecticut	General Electric
1500	50/90	600	d-c.	Direct	Reversing hot brass mill	Western Cartridge Company	East Alton, Illinois	Westinghouse
1500	250/610	600	d-c.	Geared	Continuous rod mill	Sheffield Steel Company	Houston, Texas	Westinghouse
1500	250/610	600	d-c.	Geared	Continuous rod mill	Sheffield Steel Company	Houston, Texas	Westinghouse
1500	250/610	600	d-c.	Geared	Continuous rod mill	Sheffield Steel Company	Houston, Texas	Westinghouse
1500	600	4600	60*	Geared	3-high bullet mill	Allegheny-Ludlum Steel Corporation	Dunkirk, New York	General Electric
1500	300/600	600	d-c.	Geared	Cold strip mill	American Rolling Mill Company	Butler, Pennsylvania	General Electric
1500	300/500	600	d-c.	Direct	2-stand temper mill	Republic Steel Corporat ion	Niles, Ohio	General Electric
1500	250/500	600	d-c.	Direct	Reversing cold strip mill	Sharon Steel Corporation	Sharon, Pennsylvania	General Electric
1500	50/75	600	d-c.	Direct	Reversing brass mill	Revere Copper and Brass Company	Chicago, Illinois	General Electric
1750	150/450	600	d-c.	Geared	Rod and merchant mill	Columbia Steel Company	Pittsburg, California	General-Electric
2000	175/350	600	d-c.	Geared	1-stand mill	Aluminum Company of America	Alcoa, Tennessee	Allis-Chalmers
2000	175/350	600	d-c.	Geared	2-stand tandem mill	Aluminum Company of America	Alcoa, Tennessee	Allis-Chalmers
2000	175/350	600	d-c.	Geared	2-stand tandem mill	Aluminum Company of America	Alcoa, Tennessee	Allis-Chalmers
2000	175/350	600	d-c.	Geared	2-stand tandem mill	Aluminum Company of America	Alcoa, Tennessee	Allis-Chalmers
2000	175/350	600	d-c.	Geared	2-stand tandem mill	Aluminum Company of America	Alcoa, Tennessee	Allis-Chalmers
2000	440	6600	60*	Geared	26 in. billet and structural mill	Sheffield Steel Company	Houston, Texas	Westinghouse
2000	440	6600	60*	Geared	26 in. billet and structural mill	Sheffield Steel Company	Houston, Texas	Westinghouse
2000	450/690	600	d-c.	Geared	Rod and merchant mill	Columbia Steel Company	Pittsburg, California	General Electric
2500	250/500	600	d-c.	Geared	Aluminum structural mill	Reynolds Alloys Company	Lister, Alabama	Westinghouse
3500	200/400	600	d-c.	Geared	79 in. hot strip mill	Bethlehem Steel Company	Bethlehem, Pennsylvania	General Electric
3500	175/350	600	d-c.	Geared	4-high cold mill	Reynolds Metals Company	Sheffield, Alabama	General Electric
3500	175/350	600	d-c.	Geared	90 in. hot strip mill	Granite City Steel Company	Granite City, Illinois	Allis-Chalmers
4000	50/150	700	d-c.	Direct	Rail and structural mill	National Steel Company of Brazil	Valta Redonda, Brazil	General Electric
5000	0/50/120	600	d-c.	Direct	50 in. blooming mill	Aluminum Company of America	Massena, New York	Allis-Chalmers
5000	60/120	750	d-c.	Direct	Reversing blooming mill	Crucible Steel Company	Midland, Pennsylvania	General Electric
5000	360	6600	60†	Geared	19 in. continuous billet mill	Sheffield Steel Company	Houston, Texas	Westinghouse
6000	375	6600	25*	Geared	96 in. plate mill	Carnegie-Illinois Steel Corporation	So. Chicago, Illinois	Allis-Chalmers
7000	35/70	700	d-c.	Direct	140 in. reversing plate mill	Tennessee Coal, Iron and R.R. Company	Fairfield, Alabama	Westinghouse

*Induction

†Synchronous

STATISTICS OF ELECTRIC MOTORS OVER THREE HUNDRED HP

SOLD FOR MAIN ROLL DRIVE SERVICE IN THE IRON AND STEEL INDUSTRY IN 1941

COMPILATIONS

Company	*Location*	*Type of mill*	*Number of motors*	*Total horsepower*
Allegheny-Ludlum Steel Corp.	Dunkirk, New York	10 in. merchant mill	2	1,000
		10 in. mill train	2	750
		8 in. mill train	1	400
		14 in. billet mill	1	1,000
		18 in. roughing mill	1	1,500
Aluminum Company of America	Alcoa, Tennessee	Single stand mill	1	2,000
		Two-stand tandem mill	2	4,000
		Two-stand tandem mill	2	4,000
	Massena, New York	50 in. blooming mill	1	5,000
	New Kensington, Pa.	Aluminum rolling mill	1	1,250
American Brass Company	Kenosha, Wisconsin	Brass strip mill	2	700
		Cold breakdown mill	1	800
		Cold breakdown mill	1	800
		Cold breakdown mill	1	800
		Cold breakdown mill	1	400
		Cold breakdown mill	1	400
		26 in. x 40 in. reversing mill	1	900
		26 in. x 40 in. reversing mill	1	900
American Manufacturing Company of Texas	Ft. Worth, Texas	Tube mill	1	800
American Rolling Mill Company	Butler, Pennsylvania	Reversing cold mill	3	2,700
	Middletown, Ohio	80 in. skin pass reel	1	300
		54 in. skin pass reel	1	400
American Steel and Wire Company	Cleveland, Ohio	Steckel mill	1	1,000
	Joliet, Illinois	Coarse rod mill	11	9,350
Bethlehem Steel Company	Lackawanna, New York	79 in. hot strip mill	1	3,500
Bridgeport Brass Company	Indianapolis, Ind.	Reversing hot brass mill	1	1,000
		Cold brass mill	2	1,600
		Cold brass mill	1	500
Canonsburg Steel and Iron Works	Canonsburg, Pa.	Tube mill	1	800
Carnegie-Illinois Steel Corporation	Dravosburg, Pa.	48 in. two-stand temper mill	3	2,100
	South Chicago, Ill.	96 in. plate mill	1	6,000
Chase Brass and Copper Company	Euclid, Ohio	Reversing hot brass mill	1	1,000
		Cold strip mill	1	400
		Cold strip mill	1	400
	Cleveland, Ohio	Cold brass mill	1	800
		Cold brass mill	1	800
		Cold brass mill	1	1,250
	Waterville, Connecticut	Piercing mill	1	1,250
Cold Metal Products Company	Youngstown, Ohio	Steckel mill	3	1,500
Columbia Steel Company	Pittsburg, California	Rod and merchant mill	9	7,650
Crucible Steel Company	Midland, Pennsylvania	Reversing blooming mill	1	5,000
Granite City Steel Company	Granite City, Illinois	90 in. hot strip mill	1	3,500
National Steel Company of Brazil	Volta Redonda, Brazil	Rail and structural mill	1	4,000
National Tube Company	Pittsburgh, Pennsylvania	Tube mill	1	800
Phelps Dodge Corporation	Los Angeles, California	Piercing mill	1	750
Republic Steel Corporation	Monroe, Michigan	66 in. skin pass mill	1	700
	Niles, Ohio	Two-stand temper mill	3	2,300
	Warren, Ohio	20 in. skin pass mill	1	350
Revere Copper and Brass Company	Chicago, Illinois	Two-stand cold brass mill	2	2,000
		Cold brass mill	1	1,000
		Cold brass mill	1	1,000
		4-high cold brass mill	2	2,000
		Reversing brass mill	1	1,500
Reynolds Alloys Company	Lister, Alabama	Aluminum structural mill	1	2,500
		Skin pass mill	2	2,050
Reynolds Metals Company	Sheffield, Alabama	4-high cold mill	1	3,500
Scovill Manufacutring Company	Waterbury, Connecticut	Brass mill	1	500/375
Sharon Steel Corporation	Sharon, Pennsylvania	Reversing cold strip mill	3	2,500
Sheffield Steel Company	Houston, Texas	19 in. continuous billet mill	1	5,000
		26 in. billet and structural mill	2	4,000
		Continuous rod mill	3	4,500
Tennessee Coal, Iron and R. R. Company	Fairfield, Alabama	140 in. reversing plate mill	1	7,000
		42 in. temper pass mill	4	2,400
		Temper pass mill	2	1,000
Texas Steel Manufacturing Company	Ft. Worth, Texas	Tube mill	1	800
		Tube mill	1	800
Western Cartridge Company	East Alton, Illinois	Reversing hot brass mill	1	1,500
		Brass breakdown mill	1	1,000
		Two-stand cold mill	2	2,000
		Single-stand finishing mill	1	800
Winchester Repeating Arms Company	New Haven, Connecticut	Brass breakdown mill	1	1,000
		Brass rundown mill	1	1,000
Youngstown Sheet and Tube Company	Youngstown, Ohio	Continuous billet mill	6	4,000

Types of motors purchased	*Total motors*	*Total horsepower*
Alternating current motors	31	106,100
Direct current motors	92	38,350
Total	123	144,450

swing 200-300 per cent in the space of one cycle, with swings lasting five or more cycles, and occurring five or six times in a second, precautions must be taken to eliminate disturbance in the remainder of the power system. Methods for effecting this include the use of series capacitors, synchronous condensers or motor-generator sets, changes in the inherent design of the system, or special time-operating schedules. Special attention to the inherent design of the system seems to be the most usual and most acceptable method of correction.

In transformer construction, every effort is made to obtain increased protection and safety. Improved insulation and spacers are used. Pancake and helical type windings, after thorough drying, are clamped in a hydraulic press down to a pressure equal to the short-circuit stresses that might be encountered if the transformer should be subjected to a dead short under full voltage, and are so treated as to maintain their shape. Motor operated tap changers have been improved and many safety features incorporated. High voltage tap changers may employ silver alloy inlays on the sliding contacts.

The application of 250 volt mercury arc rectifiers is proceeding steadily in the steel industry on general d-c service. The past year has seen the greater part of this development, only two 1,000 kw units having been installed in the steel industry prior to 1941. To protect rectifiers in case of arc back by quickly removing the short circuit from both the d-c bus and the rectifier power transformers, a high-speed air circuit breaker was developed. This new anode protector is a six-pole unit, with all poles independent, so that a single pole in a faulty anode circuit may open without tripping the other poles.

In switchgear the trend toward metal clad, factory assembled, centralized equipment continues to grow. New designs have been produced to accommodate various switchgear units.

A dual thermal-magnetic overcurrent tripping device was developed for air circuit breakers up to 600 amp. This device consists of an electromagnet excited by the current in a series coil, a hinged laminated iron armature which is normally restrained and held away from the pole face, and a bimetallic thermal element heated by the current induced in a short circuited turn of copper around the magnet core. The calibration range is 80-120 per cent of breaker rating. At currents exceeding ten times the breaker rating, the magnetic force of the series coil overcomes the restraint of the spring and snaps the armature against the pole face, instantaneously tripping the breaker without waiting for the thermal element to heat up.

Control equipment has been improved in many ways calculated to give longer life, reduced maintenance, and faster operation. One new design announced last year uses single contact, thus reducing the moment of inertia of the auxiliary arm and resulting in faster operation. A more efficient magnetic circuit with bi-polar magnet construction makes the flux effective at both air gaps instead of one.

A control system developed for a new blooming mill uses differential amplifying exciters and relaying contactors, none of which carry any heavy current. Thus, the heavy current contactors previously used in the fields of the main machines, as well as the old system of voltage and time relays, voltage regulator, current limit regulator, etc., are all eliminated. The new system offers simplicity, reduced floor space, reduced maintenance, fast acceleration and deceleration, and improved voltage maintenance.

For use on the tilting motion of bessemer convertors and hot metal mixers, a control system was announced, using two series-wound brakes, each equipped with two separate windings for positive release of both brakes should one motor become disabled. The two operating motors are usually of such size as to permit emergency operation by one motor. With the new system of control, if a fault occurs in the brake, the motor, or the controller of either circuit, the other circuit maintains constant operation until the vessel is restored to a safe position, no operation of switches being required. Controllers and wiring are also simplified in this system.

In other fields, various improvements have been made in control systems. A differential regulator, working in connection with the wind-up reel motor of a pickling or cleaning line, is used to maintain uniform lineal speed of material. For loop control in high-speed processing lines, where accurate synchronization is necessary, the use of a buck-and-boost generator has been extended. Variable voltage control on multi-motor wire blocks offers smooth operation. Greater use is being made of differential amplifiers for controlling excitation on motors and generators to give constant voltage, current, speed or tension, and to obtain quick response to regulation of constant output of the machines.

Production of industrial storage batteries has expanded rapidly, both in number and in unit size. Their use as standby power sources has grown, particularly for electrical machinery in processes which, once started, cannot be stopped before completion without spoiling

New designs of motors, offering greater protection and many improvements, were received with interest by the industry.

the work. Many batteries are also required in various units of armament.

The trend continues toward larger batteries in industrial trucks, particularly those on 24 hr operating schedules. The use of 12 hr batteries is rapidly superseding the use of 8 hr batteries, reducing time lost in battery changes. Single units rated as high as 64.8 kwhr are now available for industrial truck use.

During the year a new explosion-proof standby battery was put into production. With these units, naked flames in contact with the gases generated while charging the cell do not cause an explosion.

An interesting item concerns the installation of generator and transformer leads and substation ties in oil-filled, welded steel pipe lines rather than using the conventional bus structure. This is the same scheme used for underground transmission lines, replacing the conventional duct line. These cable systems give high dielectric strength and high current capacity with little space requirement.

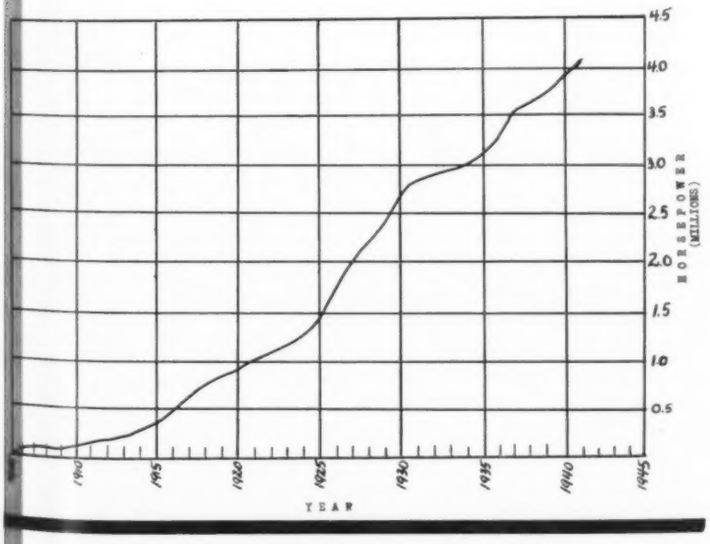
Mercury lamps are now available in sizes as large as 3,000 watts, rated at 120,000 lumens. In spite of its high capacity, this unit is only 55 in. long. With proper mounting and reflector units, one of these lamps will give over 50 foot candles at the work plane, and is equal to eight of nine 400 watt units.

New sealed cover construction on fluorescent lighting units has extended the practical use of this type of illumination to locations requiring vapor-proof or dust-tight fixtures, opal glass diffusing fixtures, or unbreakable glass protection of lamps and reflecting surfaces. The protective cover on these one-piece units is hinged to the lamp housing and locked in place by means of hand-operated cover clamps.

Records kept by a large steel plant show that the life of electric lamps exposed to vibration and shock was greatly increased by use of a shock absorber in which the fixture and lamp support floats in flexible sponge rubber, which absorbs shocks in all directions. The shock absorber, in which metallic connection between fixture and vibrating structure is completely eliminated, is easily attached to any fixture accommodating lamps of 100-750 watts.

Other tests have also shown that lamp bulbs may be treated with a clear glass coater which greatly reduced darkening of the bulb in service. The treatment also seems to eliminate pitting and adherence by welding spatter and breakage by cold water on the hot bulb. The coating operation is simple to perform and is also beneficial for other glass surfaces exposed to severe conditions.

The cumulative curve of main drive motors over 300 hp shows a present total of 4,045,665 hp. One hundred and twenty-three motors (144,450 hp) were added in 1941.



WELDING AND MECHANICAL DEVELOPMENTS

It has been well demonstrated that welded construction in an almost infinite number of steel plant equipment items offers advantages in reduced cost, stronger construction, longer life expectancy, and a reduction in construction time. Many applications of welded design are brought out by contests conducted on a national basis by one manufacturer of welding equipment. It is to be regretted that many more, particularly in the steel plant, are "born to blush unseen."

As it has in the past, arc welding keeps pace with the requirements of the industry. Many new products were introduced during 1941, many of them answering requirements of the national defense program. Arc welding machines have been designed purposely for work in aircraft production. Such machines feature particular emphasis upon accurate control of welding current and voltage, so that high speed, high quality operation is assured.

Complete protection of the welding machine against heat or excessive current is provided by a new protective control device. This consists of two current transformers, the primaries of which are connected in series with the motor leads, while the secondaries supply power to operate two snap-action thermostats which are mounted directly on the motor lamination. These thermostats are connected to the lamination in such a way that they operate by means of heat conduction as well as by current passing through the thermostat. Thus, the circuit is opened by either high temperature or high current, assuring complete protection against burn-out.

A new ignitron tube for resistance welder control has appeared. This tube is water-cooled in a rather unique manner, depending upon a special clamp into which it is fitted. The clamp is a brass block with water passages, and also serves as the cathode connection. A pair of these tubes is capable of controlling 265 kva of resistance-welding load on a 5½ per cent duty cycle. With suitable control, they can be used also for accurate short-time welding.

A stride toward increased use of welding in fields where it was not previously particularly successful was achieved by the introduction of new welding alloys. The feature of these new alloys is their property of flowing and binding at unusually low temperatures, below the critical transformation points of metals and before the formation of critical stresses. The new alloy

rods are closely adapted to the metal to be welded in color, appearance, physical properties, and corrosion resistance. These alloys are of particular use in salvaging defective machine castings of cast or malleable iron, steel, copper metals, aluminum, nickel alloys, etc., and in joining sheet metal, forgings, and castings. Dissimilar metals and dissimilar gauges can be easily joined, and strength is superior to brazing. The alloys are used with a specially adapted flux, and are mostly applied in conjunction with the acetylene torch, but may be used as well with the arc, natural gas, or in furnace brazing.

The introduction of compact, self-contained lubricating units, including provisions for storing, filtering and circulating the oil, all combined into one completely assembled unit, has brought the advantages of efficient lubrication to many applications where the use of the more complicated systems was impractical. The new units are made in a variety of sizes and types to meet industrial conditions, and their installation requires only hooking up pipe lines and wiring.

Another phase of this simplified application of efficient lubrication is to be noted in the development of a non-reversing, single-inlet, multi-outlet distributor feeder. This feeder consists of three or more sections, each of which discharges a definite quantity of lubricant alternately through one or two discharge outlets directly connected to bearings. The volume of different sections of the same distributor may vary, so that by selecting the proper number and capacity of sections and supplying the proper amount of lubricant to the inlet, a single distributor, discharging progressively through one outlet after another, will deliver the desired amount to all the connected bearings even though they may differ widely in requirements. These distributors can use either oil or grease as a lubricant.

The use of some form of oil conditioning equipment is increasing, and generally pays dividends in the saving of oil, improved lubrication, etc. One unit of this type, especially designed for oils of low viscosity and high demulsibility, consists of a hot water bath, dehydration elements, a precipitation chamber and filtration elements, all grouped in a single unit. Thus, the oil is washed for acid correction, heated to aid precipitation of solids and separation of water, and finally filtered. The unit is particularly applicable to turbines and other similar equipment.

Lubrication at very high temperatures may be improved by the development of a petroleum lubricant which completely evaporates without leaving a residue of carbon. The constituents of this product are all petroleum derivatives and are not in themselves lubricants. When properly combined, the mixture possesses good lubricating value. The new product is available in several viscosities to meet varying lubrication methods, and may also carry colloidal graphite should the application require it.

The application of fabric bearings has steadily increased in the steel plants. These bearings are available in an innumerable variety of shapes and sizes and offer a low frictional coefficient, a high resistance to weak acids and weak alkalis, and excellent strength characteristics. They are made for grease or oil lubrication, for water lubrication, and for some unlubricated applications. Installations on troublesome applications, for blooming roll necks to cranes and conveyors, have overcome chronic difficulties and given excellent results.

Close scrutiny of bearing usage in many types of auxiliary equipment shows a greater use of plain bearings where anti-friction bearings were formerly applied. In view of the many advantages of the anti-friction bearings, this may seem surprising, until further analysis brings out the reason for the change. The great demand for anti-friction bearings has tightened deliveries to a point where equipment manufacturers, with the customer's consent, are substituting plain bearings in order to expedite their own delivery.

A water treatment, designed to minimize corrosion and prevent scale formation in plant water systems, coolers, etc., has been applied in several steel plants in different sections of the country, and has proved to be practical and effective. Termed the "threshold treatment," the process consists of the introduction of two parts per million of sodium hexametaphosphate into the water supplied to the system. Results from the various applications seem to indicate that this process should merit wider use where problems of scale formation or corrosion are encountered.

It is interesting to note that automatic control for water softening plants has followed the lead of furnace controls. An entire plant may be controlled from a single, central panel board, the control centering around a flow meter. Contactors are placed on the integrator train of the meter. As these contactors close the circuit operating a time-cycle relay, the proportioner motor is started, and runs for a definite interval, lowering the swing draw-off pipe into the chemical solution a definite amount. This interval may be varied as desired, thus varying the chemical dosage. Any number of chemical feeds can be controlled from a single flowmeter, but each feed can be adjusted independently. Almost any combination of water treatments may be controlled in this manner.

The application of radial fin construction to water filters has proved its value in hydraulic systems, etc. All water passes through special fabric filter mediums having the advantage of high efficiency plus minimum restriction. The radial fin construction permits large filtering area in small space, permitting long periods of operation without attention.

One manufacturer has developed a complete line of pipe cleaning equipment, including mechanical equipment, for cleaning hearth cooling coils, bosh cooling water lines, etc.; electrically operated units for cleaning straight or bent tubes as small as $\frac{3}{8}$ in. inside diameter; cleaning heads holding blades or brushes. This company has also established contract pipe cleaning service in several sections of the country.

New simplicity of design and operating usefulness are embodied in a new printer for drafting rooms. Measuring only 32 in. wide x 62 in. long x 48 in. high, this 42 in. printer operates with either cut sheets or roll stock and prints inked tracings at 12-15 fpm. Tracings and prints are returned to a tray on top of the machine in exactly the same way as it is inserted in the machine. The light source in this machine is a 55-watt mercury vapor quartz lamp.

Methods of Increasing Production of

EXISTING STEEL PLANT EQUIPMENT

1 Coke Plants . . . . . .

W. T. BROWN, *Research Engineer,* Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania

▲ STEEL is one of the most important of the materials needed for national defense and the low coke producing capacity of the steel industry is a serious handicap to increased steel production.

The coke plant plays a very important part in the steel industry and I believe that one of the best methods for the coke plant to increase steel production with existing plant equipment, is to improve blast furnace coke—improved blast furnace coke will increase iron production.

How can we improve blast furnace coke?

We can improve blast furnace coke through research. Coal research will give us a better knowledge of the mining, cleaning, blending, expansion and carbonization properties of the blend of coals charged to the coke ovens and show us how to improve the size, structure, ash and sulphur of the blast furnace coke.

When you ask the blast furnace superintendent the question—What is good coke?—he doesn't know, but he does know how the coke works in his blast furnaces. The main requirement for good blast furnace coke is uniformity—uniformity of size, structure, ash and sulphur. Any change in the rate of operation, flue temperatures, bulk density of coal mix charged to the coke ovens, changes the quality of the coke and has a bad effect on the blast furnace operation.

Uniformity of size is the most important requirement for good blast furnace coke. The coke in the blast furnace must not only act as a fuel, but it must support and distribute the burden and act as a bed of broken solids for the proper distribution of the reducing gases. Therefore, uniformity of size is of prime importance.

We can make the blast furnace coke more uniform in size, by the installation of vibrating screens between the coke bins and the skips at the blast furnace stockhouse and screen out both the nut and breeze size coke. The nut coke is separated from the breeze and charged separately to the blast furnace. The screening out of both the nut and breeze size coke, will produce a blast furnace coke of more uniform size, which will increase iron production. If the coke at the blast furnace is properly sized, the variables at the coke plant, such as, variations in coking time, flue temperature, bulk density, moisture, etc., which affect the quality of the coke, will have less effect on the blast furnace operation.

The quality of blast furnace coke, and even the quality of the iron and steel, starts at the mines, so let us first consider the subject of coal and how its carbonization properties affect blast furnace coke.

The November 5th, 1941, meeting of the A. I. S. E. Pittsburgh District Section was in the form of a symposium dealing with increased production from existing steel plant equipment. Authors participating were (*left to right*) F. C. Swartz, Superintendent of Open Hearths, Carnegie-Illinois Steel Corporation, Youngstown, Ohio, L. E. Riddle, Superintendent of Blast Furnaces, Carnegie-Illinois Steel Corporation, Duquesne, Pennsylvania; W. T. Brown, Research Engineer, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania; L. P. Lias, Plant Metallurgist, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania; and Joseph Malborn, Engineer, United Engineering and Foundry Company, Pittsburgh, Pennsylvania.

COAL

Coal, to the domestic user, is that black rock-like material, which is mined and used for heating in cold weather or put into coke ovens to make coke. But coal is a complex mixture of hydrocarbons, laid down in the form of peat several hundred million years ago and has been subjected to many geological changes, so that every seam of coal varies in its coke making properties and even varies in every mine and each section of the mine. In order to insure uniform quality of coke, it is

necessary to blend the coal from various sections of the mines and blend coals from various seams for uniform expansion and carbonization properties and uniform ash and sulphur content.

The western Pennsylvania and West Virginia sections have been subject to many geological changes. The same geological period, which shortened the distance between Philadelphia and Pittsburgh by nearly one hundred miles, gave us low volatile coal in Somerset and Cambria counties, medium volatile in Indiana and other counties and high volatile in Allegheny, Westmoreland, Washington, Fayette and Greene counties. The geologists tell us there is a reason for every hill, valley, river bend, etc. that give us the beautiful scenery in Pennsylvania, West Virginia and other coal producing states. There is a geological reason for the variations in bituminous coal in each seam and each mine, that causes the volatile matter, expansion, carbonization properties and ash and sulphur content to vary.

The mining engineer knows that the type of roof found in each coal mine tells him much about the ash and sulphur content of the coal. For example, where there is a sandstone roof you will always find higher sulphur coal and where there is a fault, the ash content is higher and the carbonization properties different.

Research shows us that where the coal seam has been subjected to the greatest thrust and pressure, we find the lowest volatile coal and the lower the volatile matter content, the greater the expansion. Also the amount of expansion in a single mine will vary according to the geological folding, so that coal mined at the bottom of a syncline or basin, where the coal seam has been subjected to the greatest pressure, will show a greater expansion in the coke oven, than coal mined near the top of the anticline, where the pressure has been relieved.

In western Pennsylvania we find the coal with the greatest expansion in the Lower Kittanning seam from the South Fork and Johnstown districts, where the coal seam was caught between the Laurel Ridge anticline and the Allegheny escarpment and subjected to great pressure and folding. The seam dips 1700 feet in 5½ miles from the Allegheny escarpment to the bottom of the Wilmore Basin, then rises approximately 1400 feet to the Ebensburg anticline and dips again approximately 1200 feet to the Johnstown syncline and then rises more than 2,000 feet in 3 miles to the Laurel Ridge anticline.

The Lower Kittanning coal seam offers an excellent example of how geology has affected the carbonization and expansion properties of bituminous coal. In this seam we find coking coals ranging from 45 per cent expansion to 32 per cent contraction, within a distance of less than 60 miles.

In West Virginia we find 117 different seams of coal, sixty of which are minable. The coke plant operator says he is blending a certain quantity of "Pocy" in his coal mix charged to the coke ovens, but he should know more about Pocahontas coals, because they vary from contracting coals in some sections, to those that show over 25 per cent expansion in other sections of the seam, depending on the amount of geological pressure to which the seam has been subjected.

This brief description on the effect of geology on coking coals has been brought to your attention to show that in order to improve blast furnace coke, we must know more about the expansion and carbonization properties of the coals we charge to our coke ovens.

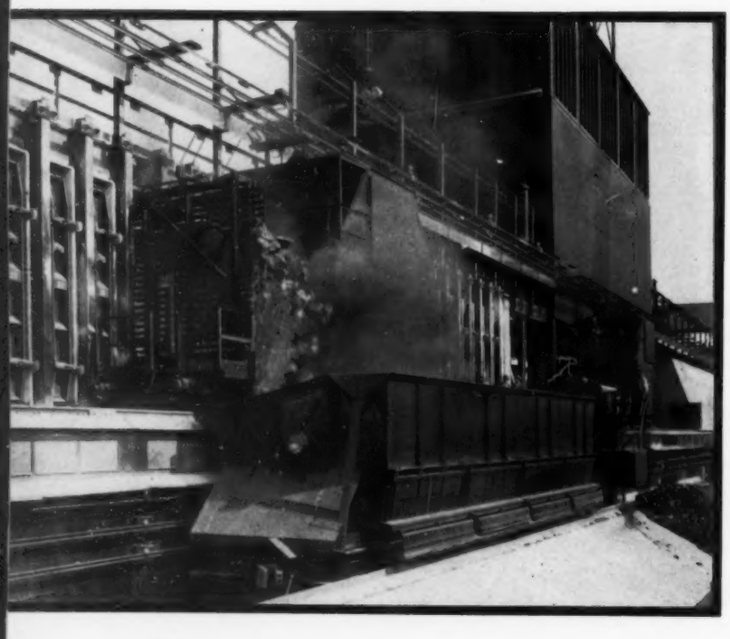
The limitations for allowable expansion of a coal depends entirely on the coal or coals with which it will be blended. A coal with even 45 per cent expansion may be blended with a highly contracting coal to produce a non-expanding coal mix. It is necessary to know both the amount of expansion of low and medium volatile coals and the amount of contraction of high volatile coals, in order to insure a satisfactory mix for charging to the coke ovens.

The United States Geological Survey, Pennsylvania State Geological Department, U. S. Bureau of Mines, Coal Research Laboratory and others have done some fine research work on the effect of geology on coal, carbonization of coal from various seams, the study of the constituents and petrography of coal, the chemical composition and the study of coke and by-products obtained from the carbonization of coals and blends from various seams. We should make better use of this valuable research in order to increase our knowledge of coals and improve blast furnace coke.

Many coke plants in the steel industry have ovens that are more than twenty years old and wonder how they can get the maximum coke production all during this emergency period.

The best method to prevent damage to the brick sidewalls of the old coke ovens, is to know more about the expansion and carbonization properties of the coals used, improve crushing and blending of the coals to prevent segregation of the expanding coals and maintain a uniform moisture and bulk density of the coal mix charged to the coke ovens.

The main requirement for good blast furnace coke is uniformity of size, structure, ash content and sulphur content.



Come coke plants use the same coal mix for both long and fast coking time, with the result that a coal mix that may be safe on long coking time will be dangerous on fast coking time. Research also shows us that all coals have a certain temperature range, where they produce the best coke, but when carbonized at higher temperatures produce small unsatisfactory coke with many cross fractures, which breaks up on handling and in the blast furnaces, causing poor iron production and excessive burning of tuyeres.

CARBONIZATION

Now that we have a better knowledge of the coking properties of coal from the various seams, let us consider how we can improve blast furnace coke by reducing some of the variables in the coke plant.

1. *Blending*—We have pointed out that there is considerable variation in each seam of coal and even coal from the same mine. Therefore, coals from various sections of each mine should be carefully blended in order to insure uniform carbonization properties and ash and sulphur content.

2. *Cleaning*—The cleaning of coal is very important for the production of uniformly good coke, because it reduces the ash and sulphur content and makes the coke more uniform. However, there is a limit to which you can lower the ash content and make a satisfactory blast furnace coke. If the ash content of the coke is less than 8 per cent, it is necessary to add gravel to the blast furnace in order to maintain a proper slag volume for some iron ores. Also the petrography and carbonization of the constituents of coal has shown us that the bright coal, sometimes called vitrain or anthraxylon, produces a fingery coke when carbonized. Therefore, it is necessary to have some fusain and finely divided ash to produce a blocky coke of good structure.

3. *Crushing and blending*—Most coke plants do not pay proper attention to the crushing and blending of the coal mix charged to the ovens. Segregation of the low volatile coal in the mix will cause non-uniform coke and is liable to cause damage to the brick side-walls of the coke ovens. Also any change in the screen size of the coal mix will change the bulk density and cause non-uniform coke. Finer crushing of the coal mix will improve blast furnace coke making it more blocky and of a higher apparent specific gravity, which means more pounds of carbon per unit volume. The loss of coke production, due to lower bulk density of the coal mix as a result of finer crushing, may be offset by oil treatment.

4. *Moisture*—Moisture content of the coal mix is very important, because variations in the moisture not only change the dry bulk density, causing non-uniform coke, but affects the carbonization of the coal mix. Moisture in the coke oven cools the gases during carbonization, producing a higher yield of valuable by-products and prevents the rapid evolution of gases at the plastic zone, allowing more time for the production of better blast furnace coke.

5. *Bulk density*—The proper control of uniform bulk density in the coal mix charged to the coke ovens, helps to produce more uniform coke. The moisture content and the screen size of the coal mix should be kept uniform in order to produce a uniform quality of blast furnace coke.

6. *Volatile content*—The control of the volatile matter content of the coke is one of the best methods for improving blast furnace coke, particularly on fast coking time. The coking of coal proceeds from the two side-walls of a slot-type coke oven toward the center and the two plastic layers meet in the center about 80 per cent through the coking period. The last 20 per cent of the coking time is spent driving out a small quantity of gases, mostly hydrogen. During this last period of coking, the coke shrinks causing many cross fractures, especially when the flue temperatures are high, as on fast coking time.

Therefore, since all coals have a certain temperature range at which they produce good quality coke, we should push what is commonly called "green coke" containing from 1.0 to 1.5 per cent volatile matter. This will prevent many cross fractures and small size coke on fast coking time.

How can we increase the capacity of our present coke ovens? We can increase the capacity of our present coke ovens by three methods, namely, by using a percentage of low volatile coal in the mix, by pushing coke with higher volatile matter content, and by oil treating the coal mix in order to increase the bulk density.

OIL TREATMENT

The oil treatment of finely crushed coal containing approximately 5 per cent moisture will increase the bulk density and thereby increase coke production as much as 14 per cent. The use of oil treatment on coarse or dry coal will not increase the bulk density in the coke ovens. The oil used for this treatment should be a naphthenic petroleum oil of about 200 sec viscosity and approximately one gallon or less per net ton should be used, depending on the bulk density desired.

When wet coal (5 per cent moisture) is oil treated, the surface of the coal particles are coated with oil which lubricates the particles so that they pack more compactly. When oil is applied to dry coal it is absorbed the same as water and lowers the bulk density.

Great care should be taken when oil treating a coal mix containing a high percentage of expanding low volatile coal, because an increase in bulk density may cause damage to the coke ovens due to expansion.

QUALITY OF BLAST FURNACE COKE

We have previously stated that the main requirement for good blast furnace coke is uniformity—uniformity of size, structure, ash and sulphur. We believe that uniformity of size is the most important requirement.

We believe that the proper sizing of coke at the blast furnaces will do more to increase iron production than any other single improvement. The coke should be closely sized between 2 in. and 3½ in. size screen and any nut coke available should be charged separately.

There have been many tests applied to coke in order

to determine the difference between good and bad coke and we will discuss these values as follows:

1. *Reactivity*—There has been much said about using a reactive coke in the blast furnace, but tests so far developed are only a measure of ignition temperature or combustibility and not reactivity. Since all the air for combustion in the blast furnace is consumed with the production of carbon monoxide within a short distance from the tuyeres, the temperature of combustion is relatively constant and independent of coke properties.

2. *Shatter test* is useful for testing coke only as an indication of how it will break up on handling.

3. *Tumbler test* is useful only as a method for determining the quantity lost by abrasion in handling.

4. *Screen test* is very important for control of close sizing at the blast furnace skip.

5. *Apparent specific gravity* is very important for determining the pounds of carbon per unit volume of coke. The higher the apparent specific gravity of a coke of a given ash content, the greater the amount of carbon per unit volume.

6. *True specific gravity* does not change very much for different cokes and it is not necessary to determine.

7. *Porosity*—Since the coke burns on the outside surface only, the test for porosity is not necessary.

8. *Bulk density* is very important if the coke to the blast furnace is charged by volume.

9. *Ash*—The determination of ash in coke should be run daily and composition of the ash run often in order to properly figure the blast furnace burden.

10. *Sulphur*—The determination of sulphur should be run daily or figured from the coal mix charged to the coke ovens by a satisfactory formula, because coke is difficult to sample properly.

11. *Moisture*—The determination of moisture should be run at least daily particularly for better control of weight per cubic foot, if blast furnace is charged by volume.

SULPHUR IN BLAST FURNACE COKE

When the sulphur in the iron at the blast furnaces tests high, the blast furnace superintendent blames the coke, but it is possible to make high sulphur iron with low sulphur coke and vice versa it is possible to produce low sulphur iron with high sulphur coke.

At most blast furnaces the only sulphur determination run is on the coke and no tests are run on the iron ores, scrap, sinter and flux going into the furnaces, but sulphur tests are run on the slag and iron coming from the furnace, but not on the top gases or flue dust.

We will take an average furnace operating properly and find that the iron tests .033 per cent sulphur or .66 lb of sulphur per ton of iron and the slag from 21 to 24 lb of sulphur where the slag volume is 1200 lb per ton of iron and contains 1.75 per cent to 2.00 per cent sulphur.

Now let us take an average coke at 1.10 per cent sulphur using 1800 lb of coke per ton of iron, we would have 19.8 lb of sulphur per ton of iron, but in normal operation only .66 lb goes into the iron or 3.33 per cent. Now if the sulphur in the coke was increased to 1.20 per cent and the same quantity went into the iron (3.33 per cent) we would have .72 lb of sulphur per ton of iron or .036 per cent sulphur in the iron. This shows there is more sulphur coming from the furnace in the iron and slag, than contained in the coke, so that the amount of sulphur in the iron ores, scrap, sinter and flux should be considered. For example, the iron and slag show 21.66 lb of sulphur per ton of iron and there was only 19.8 lb of sulphur in the blast furnace coke, leaving approximately 2 lb of sulphur per ton of iron coming from the ore, scrap, sinter, flux, etc., and not including the sulphur going off in the flue dust or top gases. Therefore, when the sulphur in the iron goes up to .060 per cent there is some reason beside the coke which is causing the trouble.

The blast furnace operator should not put the blame on the coke plant for high sulphur iron, but should look to the operation of his blast furnace for the cause, which may be the kind, quantity or distribution of the limestone used or the fluidity of the slag.

CONCLUSIONS

1. One of the best methods for the coke plant to increase steel production with existing plant equipment is to improve blast furnace coke—improved blast furnace coke will increase iron production.

2. We have shown how coal research will give us a better knowledge of the coals used in the mix charged to the coke ovens and how geology has affected the expansion and carbonization properties of the various coals.

3. The best method to prevent damage to the present coke ovens, some of which are more than twenty years old, is to know more about the expansion of the coals used in the mix charged to the coke ovens.

4. We have discussed the variables at the coke plant that cause unsatisfactory blast furnace coke and how to reduce these variables and improve the coke.

5. The capacity of our present coke ovens may be increased by the use of a percentage of low volatile coal in the mix, by pushing coke with higher volatile content and by oil treatment of the coal mix in order to increase the bulk density.

6. The main requirement for good blast furnace coke is uniformity—uniformity of size, structure, ash and sulphur. Uniformity of size is the most important requirement.

7. We believe blast furnace coke can be improved by the installation of vibrating screens between the coke bins and the skip at the blast furnace stock-house and screen out both the nut and breeze size coke and charge the nut size separately to the blast furnace. Improved blast furnace coke will increase iron production.

2 Blast Furnaces . . . .

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▲ THIS paper deals with the subject of how to obtain greater production from existing blast furnace plant equipment. In this connection, I shall endeavor to discuss the various changes which have been made, or can be made in connection with blast furnace equipment, materials and processes.

During the past twenty-five years, the great increase in blast furnace iron production may be attributed to the increase in size of the furnaces and improvement in the raw materials supplied to them. Tonnage increases have resulted from the use of better equipment and a better understanding of blast furnace practice. In one large corporation the daily output per furnace has increased approximately 40 per cent in twenty years. Much of this improvement has been due to the increase in hearth diameter.

All our equipment has been improved. This applies to stock houses, furnace tops, linings, hearths, stoves, gas washers and blowers, all of which have made contributions to our present high standard of efficiency. Even so, we did have some excellent furnace practice and made some remarkable production records in the days when our equipment was far more crude than it is today. Today our operations are steadier, there is less variation in the quality of our iron, our fuel consumption has improved, and our yields are much better than formerly.

Stockyard refinements were instituted some twenty years or more ago. They included better tracks, scale cars, coke screens, and hoisting machinery. Following these improvements came bigger stoves, better control equipment such as stock line recorders, hot blast control and remote control mud guns. The electrical precipitators for gas cleaning, used in connection with a tower washer having no moving parts, represent a long step forward in securing reliability and low cost operation. The day when reciprocating steam blowing engines and small capacity iron ladles would do is long past.

One of the main factors in securing improved output and greater uniformity of operations has been the better quality of the coke now obtainable. Coke made from coal mixtures containing low-volatile coal has demonstrated its advantages, increases in pig iron output of from ten to twenty per cent being common when this type of coke is used. Such a practice results in a long train of advantages, extending through the whole steelmaking process. And further, it should be noted that coal washing has proved beneficial, as well as other refinements introduced in coke plant practice during recent years.

INCREASING PRODUCTION FROM EXISTING EQUIPMENT

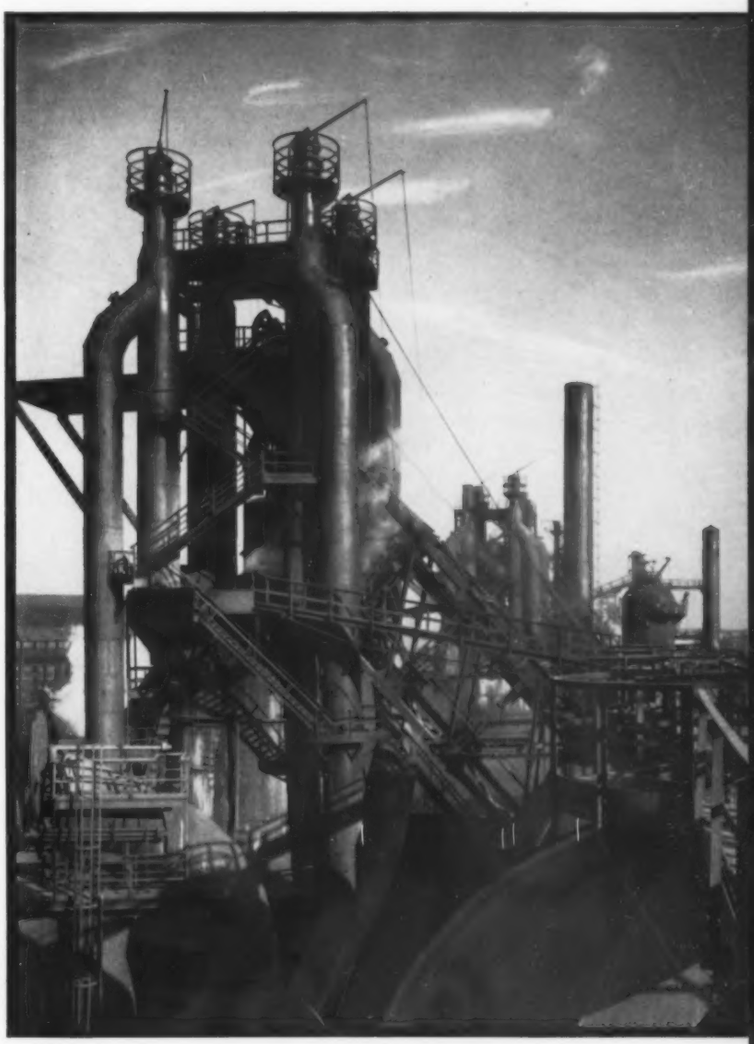
In the following discussion, "existing equipment" should be understood as relating to the furnace proper.

Blowing rate—Increased blowing has been chiefly responsible for the increase in furnace production during the past year. This was necessitated by increased demands for iron for defense and other emergency purposes and we should see to it that all our furnaces are blown at the maximum rate.

In the Pittsburgh district, where practically all the coke used is made from high-volatile coal, furnaces should be blown with at least 150 cu ft of air per minute per square foot of hearth area, figured by the carbon method. Where coke made from mixtures containing approximately 50 per cent of low-volatile coal is used the rate should be not less than 160 cu ft of air per minute per square foot of hearth area.

In some cases the desire to attain low coke rates has kept blowing rates below these minimums. Under present conditions, however, higher coke rates resulting from an increase in wind rates will have to be accepted. Where existing blowing equipment does not permit

The great increase in pig iron production may be attributed to the increased size of modern furnaces and to improvement in the raw materials supplied to them.



these minimum blowing rates to be attained, additional facilities must be installed.

Stoves—Maximum production demands a stove capacity equivalent to 500 square feet of heating surface per net ton of rated iron capacity. If this is not available, frequently it can be provided by installation of inserts. Although the use of straight line temperature of 1500 to 1600 F has been found impractical with 100 per cent Mesabi ore, stoves designed to provide this temperature have proved a good investment through their ability to meet abnormal requirements, which occur with greater frequency and severity under present operating conditions.

Both forced draft burners and automatic combustion control contribute to increased heating capacity of stoves and their utilization at plants not so equipped should be considered. Regular and frequent stack gas analysis is essential.

Air conditioning—(Dry blast) Air conditioning or dry blast plants which can guarantee the removal and maintenance of moisture to one grain per cubic foot of air delivered, if put on furnaces in the Pittsburgh, Cleveland, Detroit, and Chicago districts using natural air, should increase the tonnage 12 per cent. In the Pittsburgh district, high peaks reach 9½ grains and daily averages of 8½ grains with slight variations are not unusual during some summer periods. The moisture content, however, for 6½ months of the year averages only 2.8 grains, but with great variations throughout the day. Therefore, in order to obtain the maximum benefits from blast conditioning, moisture should be held to one grain or less throughout the year.

IRON SPECIFICATIONS

Sulphur—Highly basic blast furnace slag and excessive slag volume, both necessitated by low sulphur specifications in pig iron, are not conducive to maximum production. Increasing the maximum allowable sulphur from maximum of .030 in hot metal to .035 to .040 will, in many plants result in a greater overall production rate. In certain plants the sulphur content of other materials used in the open hearth process is such that an increase in the sulphur content of the pig iron will immediately result in either an increase in the sulphur content of the steel or a decrease in open hearth production.

In view of the foregoing, it appears mandatory that the possibility of raising sulphur specifications in the finished steel product be thoroughly investigated.

Where specifications of iron for open hearth and bessemer use require extremely low sulphur pig iron, care should be exercised to the end that the maximum sulphur content be permitted that will not reduce production of finished steel commodities.

Phosphorus and manganese—Phosphorus and manganese specifications are often too rigid to permit the most advantageous use of open hearth slag. Due to the available lime in open hearth slag and to its physical characteristics, more extensive use of this material usually results in an increase in iron production. At plants where the additional slag volume resulting from its use is not required for desulphurization, the opposite effect will be obtained; despite the fact that open hearth slag will replace limestone, the total slag-forming oxides per metallic unit greatly exceed that of iron ore and its limestone requirement.

RAW MATERIALS CHEMISTRY

Coke—There is nothing we could do that would make for a greater increase in production from furnaces now in blast than to give them a lower sulphur, lower ash more uniform coke. This could best be accomplished in the Pittsburgh district by washing all the coal. In this district, the addition of low-volatile coal would be helpful but such a practice would be impractical in most existing coke plants in western Pennsylvania.

In other districts, where sulphur and high ash content do not present a serious problem coke quality could be improved by coal mixing and bedding, which would make it possible to burden closer to the optimum iron-to-coke ratio and consequently increase the production rate.

Ore—Silica present in ore in excess of that required for the maintenance of adequate slag volume should be avoided wherever possible. Some plants have found that slag volumes can be carried as low at 700 lb in standard basic iron and 650 lb in bessemer iron without unfavorably affecting their iron quality and with a resultant decrease in coke consumption and an increase in production.

Bedding ores in stock piles will improve analysis uniformity and have a consequent beneficial effect on furnace operation and production.

Open hearth slag—The use of open hearth slag is general, but in some plants the high manganese and phosphorus in the iron resulting from its use is objectionable. Here again the increased production of pig iron due to the greater use of open hearth slag should be so balanced that finished steel output does not suffer.

Segragating tapping open hearth slag from flush open hearth slag is important if maximum benefits are to be obtained from its use. Tapping slag is generally lower in phosphorus and manganese and higher in available lime than is flush slag. Furthermore, tapping slag is generally more uniform in analysis.

Bessemer slag—The use of bessemer slag as a source of metallics should be avoided wherever possible. A ton of bessemer slag of typical analysis will require half a ton of coke for smelting and one ton of flux, and with that flux will make about one and one-fourth tons of blast furnace slag.

Scale—The use of rolling mill scale in the blast furnace burden is always helpful, but when this material is contaminated with foreign materials such as hot-top brick, an effort should be made to eliminate these coke consuming and slag making constituents.

Scrap—All furnace men now use all the scrap available; consequently, no improvement can be expected from this source of material.

PHYSICAL CHARACTERISTICS OF RAW MATERIALS

Coke—Screening of coke is preferably carried out at a point near the furnace and will result in increased production. Where coke size varies widely, crushing, followed by screening, will also be beneficial.

Ore—Ores having high fines content decrease the production rate. Although the choice of raw materials is not always under the operator's control, it is sometimes possible to distribute the ores carrying abnormally high fines in such a way that the overall flue dust production will be less than if these ores were used without regard to the characteristics of the individual furnaces.

Flux—Limestone should be crushed, washed and screened to a size not less than ½ in. and not more than 5 in.

Sinter—It is generally recognized that the addition of sinter to the blast furnace burden will increase the production rate, pound for pound more than any other material except scale. Where all available sintering capacity is being utilized, sinter production can sometimes be increased by the addition of ore fines. This results not only in the obvious advantages due to additional sinter production for blast furnace use, but also sometimes increases flue dust consumption. Some benefit will also accrue in the blast furnace burden if the ore fines are obtained by screening.

AUXILIARY EQUIPMENT

Mud guns—Where undue delays are experienced because of tapping hole trouble, furnace production rates can often be improved by the installation of remote control mud guns, if such equipment is not now in use. The ability of these guns to stop tapping holes without lowering blast pressure results in continuous operation, with the resultant benefits of regularity and increase in tonnage.

Instruments—Automatic stock line recorders, automatic control of hot blast and stove dome temperature, as well as stove stack temperature recorders are all necessary to the maintenance of maximum production. Atmospheric humidity recorders have been used to good advantage in some plants to facilitate accurate adjustment of the hot blast temperature to the amount of moisture in the blast.

Maintenance—Under present operating conditions, the importance of adequate maintenance cannot be over-emphasized. Increasing the frequency of periodic inspections often will decrease time losses due to breakdowns.

Careful scheduling of major repairs and close cooperation between blast furnace operator and the maintenance department will result in the maximum use of time during enforced shutdowns.

Relining and rebuilding—We would like also to add a word about furnace construction. Furnaces should be relined to as great a hearth diameter as the existing shell will allow. On reconstructions, furnaces should be built to 27 ft or 28 ft hearth diameter, and not less than 105 ft high. When furnace dimensions are increased, blowing equipment and stove heating surface should be increased accordingly to obtain the maximum benefits of the increased size.

In conclusion, it is our opinion that blast furnace production rates per square foot of hearth area per day should, for furnaces with Mesabi ore and a scrap-free burden, be equivalent to at least 2.24 net tons where the coke is made from 100 per cent high-volatile coals and at least 2.45 net tons where low-volatile coals make up 50 per cent or more of the coal mix. Performance of furnaces now producing at less than these rates might be reviewed advantageously in the light of items we have presented.

Intelligent supervision, possible only after long practical training, is necessary to obtain maximum tonnage and economy in blast furnace practice.

3 Open Hearths . . . . .

F. C. SWARTZ, *Superintendent of Open Hearths,* Carnegie-Illinois Steel Corporation, Youngstown, Ohio

▲ NEVER in the history of the steel industry has the demand for steel been greater than at the present time. In spite of a present increase to 86,148,700 net tons annual ingot capacity of open hearth, bessemer, electric and other steels, as reported by the American Iron and Steel Institute as of June 30, 1941, it is assumed that this capacity must be greatly increased to meet the estimated steel requirements for 1942.

An estimate of 76,100,000 tons of ingots per year has been given recently as the present open hearth steel making capacity, of which about 1,500,000 tons was additional capacity placed in operation during the first six months of this year. A considerable increase will result from expansion programs now under contruction and estimated to be completed in the last half of this year and extensive plans are contemplated for additional open hearth capacity in 1942. The problem which faces steel plant management and open hearth operators today is, what can be done to increase the production from existing open hearth furnaces?

The purpose of this paper is to review several means whereby this can be accomplished. The methods indicated, however, are only the most important. Several of the items mentioned have been or are being put to use in many of the larger open hearth plants and can be adopted at other plants where physical conditions and other circumstances permit.

Changes in furnace construction, equipment, charges, practice, etc., that will increase production or yield have been divided into three groups:

A.—Low cost improvements that can be effected quickly.

B.—Moderate cost improvements that can be effected in a comparatively short time.

C.—High cost improvements that can be completed in twelve to eighteen months.

GROUP A—LOW COST, QUICKLY MADE IMPROVEMENTS

1. *Study of delays.*—All operating delays should be recorded at least daily and monthly and an estimate made of the loss in tonnage for each item of delay. These reports should be made available to all members of the organization whose duties have a bearing upon

the delay subject, advising them currently and in concise form on the effect of delays upon production. A thorough study will reveal which delays predominate and are responsible for the greatest loss in tonnage. Steps can then be taken to reduce if not eliminate the delays.

2. *Changes in furnace design, etc.*—Change in furnace lines, port design, or checker work arrangement may be found desirable. The judicious use of water cooling equipment at vulnerable parts of a furnace to carry away destructive heat and thus preserve the lines of the furnace and the brick work, may be found advisable and effective in increasing furnace output.

3. *Manipulation of charge materials.*—In some instances, changes can be made in the charge materials, in kinds and proportions to produce faster melts and time of heats. A number of open hearth plants working with relatively high percentages of hot metal are regularly using low silicon iron thus increasing their production. Likewise a few plants are using low silica charge ore, screened charge ore, or some form of sintered ore with a resultant increase in ingot production. The use of low silica limestone also makes for faster melts.

4. *Scheduling of heats.*—Careful planning in the scheduling of heats, hot work repairs on furnaces, and proper charging for desired melts will help to avoid bunched heats in tapping thereby eliminating delayed taps and possible bad bottoms, thus increasing furnace output. Likewise, a certain degree of flexibility in orders when scheduling heats on furnaces, so that high carbon specifications, can be provided for heats analyzing high in carbon at melt-down and low carbon specifications for normal carbon melts, will decrease time of heat and increase furnace production.

5. *Furnace rebuilding.*—Careful scheduling of furnace repairs and rebuilding, with an adequate supply of labor and bricklayers available around the clock and seven days a week if needed to obtain the festest possible rebuilding time, is now practiced in many plants and is worthy of consideration in others.

6. *Use of labor incentives.*—At some open hearth plants, incentive earnings for more than normal effort and speed are paid workmen including bricklayers working on furnace hot work repairs and on all furnace rebuilding. This has been effective in speeding up furnace repairs and thereby increasing steel production.

7. *Use of basic brick.*—Basic or chrome brick are very generally used in most plants for front walls and bulkhead construction, and to some extent in wing or monkey walls and in producer gas ports. The longer life experienced with basic brick has greatly reduced lost time due to hot work repairs.

8. *Use of quick setting bottom refractories.*—There are a number of quick setting bottom making and patching materials on the market. Generally speaking they have been quite reliable and certainly have helped to speed up bottom repairs and thereby increase furnace production.

9. *Care of bottoms.*—The high temperatures required for proper refinement in the production of quality steel and for very low carbon steels, which are steadily increasing in tonnage, makes imperative the use of high grade refractories for bottom making. Considerable time will be saved in the long run by properly cleaning holes and repairing them with high grade dolomites and quick setting magnesites.

Some bottom making time can be saved by the use of compressed air, around 100 lb pressure, through a one inch pipe for blowing steel and slag out of bottom holes. The same method is useful in burning steel out of tap holes.

Very deep holes near the center of a bottom can be drained quickly if an auxiliary tap or drain hole is built into the bottom of the hearth on each side of and about 18 in. below the level of the tap hole. After the brick in the auxiliary hole are removed, an oxygen lance is used to burn through the bottom material and to the hole in the bottom that is to be drained.

10. *Use of low sulphur fuels.*—Obviously low sulphur fuels should be used to enable the production of low sulphur steels without loss of time in refining the heat and corresponding loss of tonnage. High sulphur fuels require the use of additional limestone or burnt lime in the heat and increase the time of heat.

11. *Use of liquid fuel.*—On producer gas fired furnaces, liquid fuel should be used where available while burning out underground producer gas flues to avoid loss in melting time.

12. *Job training.*—Recently job training programs

The problem of greater production from existing open hearths may be met by a combination of many small items, each contributing to the final solution.

have been started at a few plants. An experienced man, well qualified and capable of teaching other men, including furnace operators, spends all his working time at training men how best to perform their jobs, observe furnace conditions, etc. Such a training program has possibilities of effecting greater furnace output.

GROUP B—MODERATE COST, EASILY MADE IMPROVEMENTS

This group of improvements can usually be made during furnace rebuilding or when worn out equipment must be replaced because of high maintenance costs. The improvements listed in this group have been made by many plants and might well be considered by others.

1. *Use of flue blowers under checkers.*—A number of open hearth plants have installed soot blowers in the brick floor of the riderwall spaces under the checker work and in the flues immediately outside the checker chambers. Steam, or compressed air are blown through these nozzles periodically to carry the dust accummulation toward the stack. By systematically blowing the checker work and using the nozzles in the rider flues, it is possible to keep the entire checker system adequately clean for good operation throughout the campaign of a furnace, and also to lengthen the campaign.

2. *Labor saving devices.*—Probably all plants have installed labor saving devices wherever possible to speed up furnace rebuilding and thus increase steel production. Such devices include motor trucks, lift trucks for handling bricks from cars, conveyors of various kinds and even rubber tired wheelbarrows. Several plants are using large boxes, constructed of heavy plate, which are inserted in the charging door openings and across the hearth before a section of roof is to be knocked in, preparatory to making a roof patch. A box can be placed in each door opening if an entire roof is to be replaced. This scheme saves the men from hot, disagreeable work and decreases the hot work delay on the furnace. The box can be placed by use of the charging machine and the overhead crane together, but must be removed and unloaded by the crane alone.

3. *Larger charging boxes.*—The door opening on the furnace should be made as large as practical, preferably using an archless frame with a cooler built into the bottom flange of the skewback channel, in order that largest possible charging boxes can be used. Sloping the front surface of the frame assures a tight fit between frame and door. Four to six inches of clearance between the edge of box and door frame is ample and ten to twelve inches between top of box and underside of frame is sufficient. Several plants tapping 125 ton heats and over are using charging boxes with 30 to 40 cu ft capacity. The advantages of large charging boxes for faster charging and the elimination of charging delays can not be emphasized too strongly. In order to use large boxes handling heavy scrap, pig iron and ore, a sufficiently strong charging machine is required. This step may have to wait for an extensive rehabilitation program. At most plants, larger boxes than are now used, can be procured as additional boxes are needed or as replacements of old boxes are made. They can be handled with present charging machines to charge limestone, light scrap, etc., thus obtaining to a limited extent the advantages gained from the use of large boxes for all materials charged.

4. *Better scrap preparation.*—Many plants are required to use loose light weight or bulky scrap causing slow loading and charging, and consequently they experience charging delays and loss of production that could be avoided, to some extent, by proper preparation of the scrap.

Scrap balers, compressors, and coilers are employed at some finishing mills to produce heavier weight pieces or parcels of scrap but such equipment is not used as much as it should be and therefore there are many open hearth plants which suffer loss in tonnage due to the use of poorly prepared scrap. Small rounds, flats and light shapes, certainly should be tied together into a bundle or fagot, charging box length and large enough that two or three bundles will fill a large box, in order that charging boxes may contain their full normal load and be loaded in the shortest possible time.

5. *Bottom making machines.*—The use of bottom making machines to speed fettling of the furnace and to save the men in hot weather is fairly common practice. Their use is more essential, of course, on large furnaces than on small. Where high proportions of hot metal are used, they are also of especial value.

6. *Use of controls including the use of forced air fans.*—Most open hearth plants have some kind of automatic control equipment in use. Such facilities may include any or all the following—pressure control; roof temperature control; automatic reversal; combustion control, including controls of firing rates for gas or liquid fuel and fuel-air ratio. Most plants' prefer to control combustion manually rather than automatically.

Reports from different open hearths concerning the effect of each type of control on rate of steel production and the overall effect of the several control devices applied in combination to a single furnace have been somewhat at variance. The use of forced air in itself may be responsible for a major portion of the observed gain in tonnage.

7. *Use of bath pyrometers.*—Recently the use of bath pyrometers of the radiation type which are applied by means of a tube immersed in the bath, have come into quite general use in a number of plants of the United States Steel Corporation. It is quite reliable in giving accurate bath temperatures; since its application is relatively simple and convenient, it has become a great help to furnace operators and melters in obtaining desired tapping temperature. Plants having such equipment have reported a marked reduction in ladle skulls as well as running stoppers and therefore have gained a corresponding increase in ingot production. An accurate knowledge of the tapping temperature helps to improve pouring practice and also permits the melter to take necessary time to properly drain the furnace bottom into the steel ladle and thus avoid loss in scrap and increase the yield of ingots.

GROUP C—HIGH COST, MAJOR IMPROVEMENTS

Long range programs of plant improvements have been planned and undertaken by many open hearth plants in the past few years. The returns in increased production and reduced ingot costs to be obtained by

certain major improvements are frequently attractive in spite of the high first cost.

1. *Increased hearth area.*—Many open hearth furnaces are overcharged and consequently are operating with a bath that is too deep for maximum productive efficiency. By redesigning the chill box or setting it back, the hearth may be lengthened several feet. Possibly the back buckstays can also be relocated to widen the bath one or two feet.

Either or both of these changes can be made when the furnace is undergoing a general or major rebuild; they require only a few days to a week longer time to accomplish, depending upon the amount of new steel work installed. The additional cost, if the change is made at this time, will be reduced to a surprisingly low figure considering the extent of the improvement. Likewise, the production lost on the furnace during the change will be recovered within six to nine months depending, of course, upon the per cent gain in hearth area.

2. *Increased size of heat.*—A number of plants have increased the size of heat tapped. Usually where the hearth area was increased by lengthening or widening, it was accompanied by an increase in size of heat tapped. By the use of a welded ladle—it being of lighter weight than the conventional rivetted ladle—a heavier heat can be tapped without additional load on the steel crane and building structure. The experience of many plants has demonstrated that the per cent increase in rate of production to be obtained from larger heats is at least equal to one-half the per cent increase in size of heat tapped. In certain plants where heavier steel cranes were required and the building materially strengthened, the increased production from the larger heats justified the additional cost, especially at this time of maximum production requirements.

3. *Adequate supply of charging cars and charging boxes.*—There is probably no equipment more important for efficient operation of an open hearth plant and avoidance of charging delays than sufficient charging cars and boxes—preferably large boxes—in order that sufficient charges can be made up and kept in readiness at all times because heats will get bunched occasionally in the best regulated open hearth plants.

Likewise, there should be sufficient track space for storage of made up heats of scrap, limestone, and ore as close to the open hearth as possible. Preferably there should be one or more storage tracks running lengthwise to the shop and on the same level with the charging floor.

4. *Sufficient hot metal cranes and charging machines.*—If an open hearth plant expects to obtain maximum production, the furnaces must not wait for their charge and they must be charged as fast as possible. There can be no delay waiting for hot metal on any furnace to attain this goal. To meet these requirments there must be sufficient charging machines and hot metal cranes available at all times and allowance should be made for the charging machine and the hot metal crane that occasionally breaks down or is taken out of service for repairs.

If new equipment is purchased, serious thought should be given to handling much larger charging boxes and larger ladles of hot metal to obtain faster charging.

5. *Use of hot blown metal.*—A few plants are fortunate in having hot blown metal available for open hearth use. Those plants, through the use of 15 to 30 per cent hot scrap in the charge, have been able to increase the ingot production materially. Plants having the equipment required to produce blown metal might well consider the possibility of making hot blown metal available for the open hearth and thereby obtain the resultant increase in production.

6. *Installation of straight line valves and larger flues.*—Many of the older plants have replaced old style reversing gas and air valves with straight line valves thus eliminating right angle turns and water leakage which are inherent weaknesses in the older type of equipment. When replacements were made the flues were generally made larger. Most plants have increased the size of heats considerably over a period of years, without however correspondingly increasing the size of the original flues. This has often resulted in unduly high velocities in the waste gases through the flues and valves. When these bottlenecks are removed the production of a furnace can be expected to improve materially.

It has been the main object of the author to include in this paper only the most important types of improvements, purposely omitting great detail in dealing with each, and to point out the possibilities in each improvement for increasing open hearth production in response to the urgent demand for steel in the present national emergency.

4 Bessemer and Duplexing

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▲ BECAUSE of the national emergency and the unsettled world conditions in general, there is need for every ton of steel it is possible to produce. Large tonnages can be added to our present capacity by plant expansion. However, the need is urgent and time is a very important factor. Significant increases in present capacities can most quickly be obtained by readjustment of existing equipment and revision of present practices. This paper has been drawn up to stimulate thought along these lines with particular emphasis on the bessemer process which, because of its speed, offers a fertile field for development under the impetus of the present demands.

THE BESSEMER PROCESS

This process consists fundamentally of the purification or refining of pig iron by the oxidation of the carbon, manganese, and silicon. The reactions whereby this is done are the same as those taking place in the open hearth; however, they are greatly accelerated by the manner in which they are brought to take place. This is done by blowing a blast of air through molten pig iron in a converter. The process is unique in that instead of the iron becoming colder from the air, the exothermic nature of the chemical reactions make it necessary to

take steps to keep the metal from becoming too hot, such as making additions of cold scrap or introducing steam into the blast.

The bessemer process is an old one having had its birth in the middle of the last century and enjoying a very prominent place in the steel making industry until about 1906 at which time it was forced into the background with the advent of the open hearth process. The bessemer is more than self-sufficient with respect to scrap, using less than 10 per cent as a cooling agent. The supply of scrap has had much to do with the rise and fall of the bessemer process. As increasing quantities of scrap were made available through the excess produced by the bessemer and the return of materials which had served their useful life, scrap became cheaper and the bessemer process lost much of its economic advantage over the heavy scrap consuming open hearth process. However, the present situation, with its shortage of steel scrap, has again focused much attention on the bessemer process.

Successful bessemer operation first of all depends upon adequate supply of uniform bessemer iron of approximately the following composition:

Si.	Mn.	Sul.	Phos.
1.10-1.60%	.40-.50%	.040 max.	.090 max.

Sufficient mixer capacity should be available for at least an 8 hour supply of iron. This will make it possible to build up a reserve of iron over down turns and will tend to level out the fluctuations in temperature and analyses from cast to cast, especially where the iron is being supplied by more than one blast furnace. The more uniform the iron supplied to the convertor the better the job that will be done by the blower.

Four main factors must be considered in attempting to increase bessemer production: (1) The speed and ease of handling materials to and from the convertor as well as auxiliary materials; (2) keeping down time of the converting department to a minimum; (3) the efficiency of the actual blowing operation; and (4) the quality of the product produced. A thorough analysis of most converting department operations will reveal a number of possible changes which singly may not appear too significant, but collectively they may be very significant.

The quantity of materials required to be handled to keep a converting department in operation is often quite a problem. This includes the transfer of iron from the mixer to the vessel, providing and adding scrap to the convertor, and the teeming of the finished steel. Auxiliary materials required are convertor and ladle lining materials, tuyeres and spare bottoms, clay, and ferro-alloys for deoxidizing and meeting chemical specifications. Convertor slag and vessel spittings must be disposed of. Often times it is necessary to transfer these materials from cranes to narrow gauge tracks to wide gauge tracks or vice versa to get them to their destination. The extension of narrow gauge or wide gauge spurs may often profitably eliminate a handling operation. Wherever possible, wide gauge tracks should be extended into the shop in preference to narrow gauge service. This is especially desirable for handling the larger volume materials such as convertor slag, cooling scrap, bottom and vessel refuse and ferro-alloys. What can be done in these respects depends on the plant layout.

Crane service is very important. Often times cranes are too slow and time consuming in doing a specific job. It may be profitable to make the necessary changes to speed up the crane. The installation of an additional crane may be desirable to take part of the burden from on overworked crane and thus speed up general operations.

Readjustment of existing pit equipment such as pouring platforms, tracks, and mould and ingot handling equipment has been made with improved results. Adequate facilities for the prompt delivery of ingots to the stripper is desirable especially if high sulphur steel is being made.

There are certain operations that have to be performed that cannot be done without shutting down the convertor. The amount of "down time" naturally affects the tonnage produced and any steps that can be taken to decrease this time will be very desirable. An accurate record of the reasons for this lost time will enable one to determine the major offenders and take corrective measures.

The normal life of the lining in a bessemer convertor is 30,000-50,000 tons. It usually requires one to two days to reline and prepare the vessel for operation. It is very desirable to have a spare shell and repair stand so that only the time required to change vessels will be lost.

Bad iron may result in considerable slopping from the nose of the vessel during blowing. These sloppings, together with the material carried mechanically out of the vessel, will form quite an accumulation of skulls on the floor, shields, or other structure in the vicinity of the convertor which must be removed to keep the place in operation. This should be done periodically and often because small accumulations are easier to remove than large ones. The general operations of the plant will be better, equipment can be kept in better condition, and the "down time" over a period of time will be less. Too often little jobs put off till the next day become big jobs with a much greater loss. Shield skulls are often hard to remove and presents a very nasty job at the best. Water sprays located on the face of the shield will cause the skulls to curl and come off with very little effort. Instead of using a crane and a weight to knock them off, it may be possible to install a vibrator on the back of the shields to accomplish the same results.

The time required to change a bottom is quite short; however, this is an operation that is required quite often. The normal life of a bottom is 30 to 50 blows. There is much room for the improvement of bottom life. Sufficient spare bottoms for each vessel should be carried so there will be plenty of time to make up and thoroughly dry each bottom. A bottom not thoroughly cried will have a very short life. Greater care must be taken in this respect in the winter months.

The time required to blow a blow of bessemer steel varies from 10 to 15 minutes for a 25 ton charge. This time will vary somewhat depending on the analyses of the iron, the blast pressure and the bottom condition. There is not too much interest in further shortening this time, however, what takes place, how it takes place, and how to duplicate these factors from blow to blow are very significant. The skill of the blower in adjusting temperature and in turning down the blow at the proper point is very important. Given uniform material to work with and a mechanical set up with a minimum of

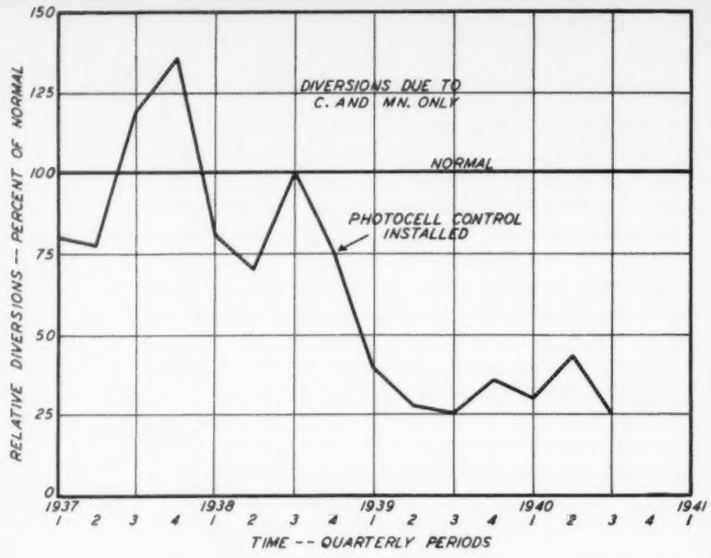

Figure 1—Effect of photocell control on the number of heats diverted.

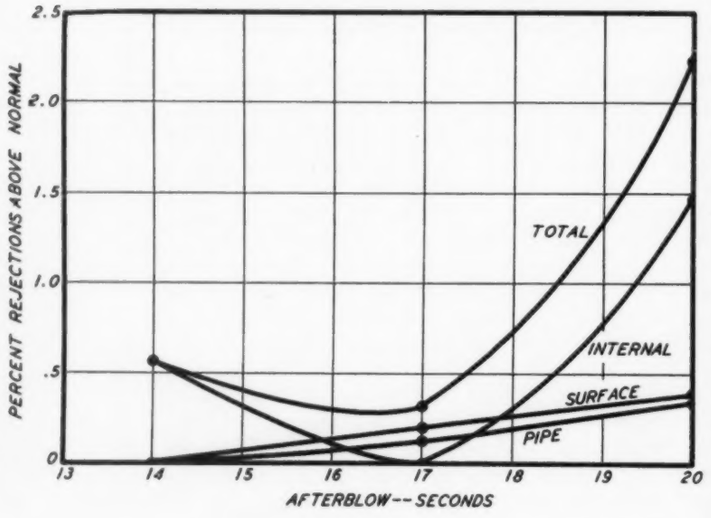

Figure 2—Variation in external and internal rejections for various periods of afterblow.

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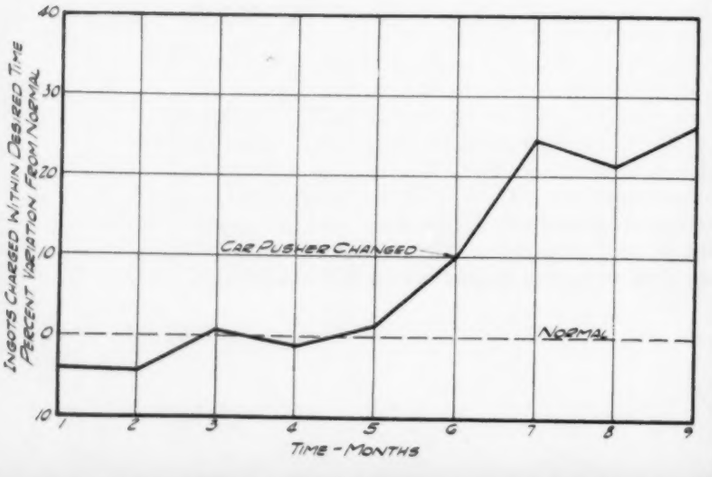
Figure 3—Effect of changed car pusher on number of ingots charged within desired time limit.



fluctuation, the results are then up to the skill of the blower.

The blast system can be streamlined by the installation of improved valves and connections. Tighter joints have been designed to prevent leaks. Elimination of sharp corners have cut down frictional losses. Such changes will increase and make more uniform the blast supply at the convertor.

The nature and speed of the bessemer blow is such that the blower does not have the chance to run preliminaries, take break tests, and pour spoon tests to follow the progress of the heat as the melter does in the slower open hearth process. The same factors must be evaluated by observing the characteristics of the flame coming from the nose of the vessel. Recently, science has come to his aid with the development of the electric eye which provides him with a quantitive record of the flame characteristics. From the height of the flame curve on the recording chart he is able to more accurately judge the temperature during the progress of the blow. The very significant end point which is used as a basis for turning down the blow, is clearly indicated at the instant of occurrence. This enables the blower to more accurately duplicate the same afterblow from one blow to the next. With closer control over the temperature and degree of afterblow, it is possible to do a much better job of duplicating analyses and quality from blow to blow. Off blows do not necessarily mean less produced tonnage; but it does mean rescheduling, the complicating of rolling schedules, and the falling behind on promised shipments, all of which decreases operating efficiency. The improvement made in this respect with the use of the electric eye is clearly shown in Figure 1. (H. K. Work—"Photocell Control for Bessemer Steel Making", A.I.M.M.E. Technical Publication No. 1300) Diversions due to carbon and manganese only were considered because these two elements are the ones most affected by blowing conditions.

The electric eye has been a big help in improving the quality of bessemer steels. A permanent chart record is made on every blow. Statistical analyses covering a large number of blows has revealed the correct afterblow for the various grades which will give the lowest surface rejections and the best internal soundness. With this information available, and using the electric eye as a control instrument, the variation in afterblow can be narrowed down to the desired point with a more uniform quality product from blow to blow. Figure 2 shows the variation in external and internal rejections for various periods of afterblow.

High rejections are not necessarily the result of poor steel making practices. Improvements in mechanical features may often have a very marked effect on the quality produced. For example, a teeming platform set-up was equipped with a hydraulic car pusher located between the teeming point and the exit end. Because of this the engine could not pull the ingots until several more blows had been poured to maintain a continuous string out past the pusher. This resulted in excessive delays in getting the ingots to the stripper and into the soaking pits. By turning the pusher around, feeding empty moulds in over the pusher, and using the opposite end of the platform for the exit end, this interval was decreased appreciably. Figure 3 shows a very marked improvement made in the proportion of ingots charged

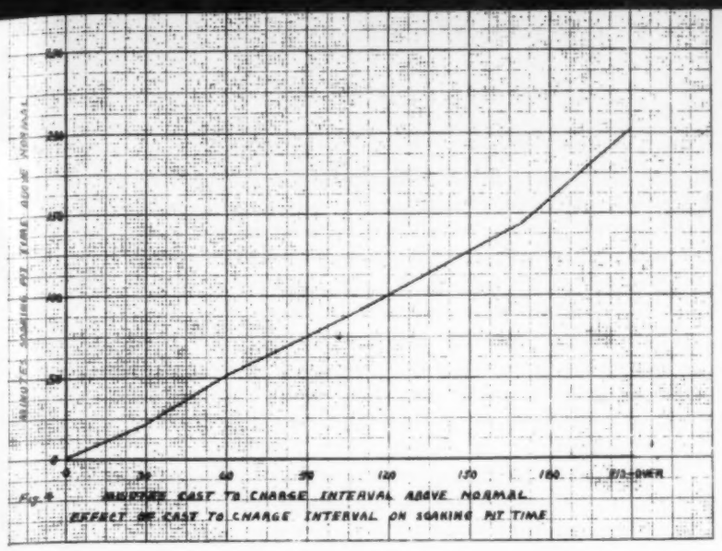


Figure 4—Relation of cast to charge interval upon soaking pit time.

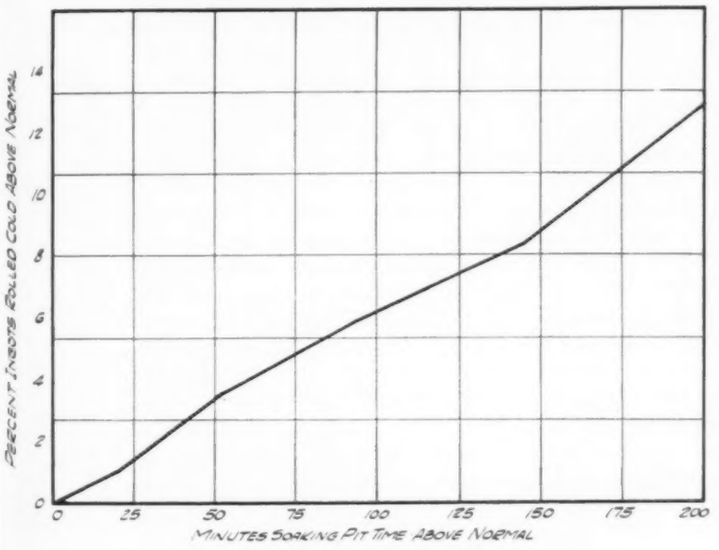


Figure 5—Relation of soaking pit time to ingots rolled below desired temperature.

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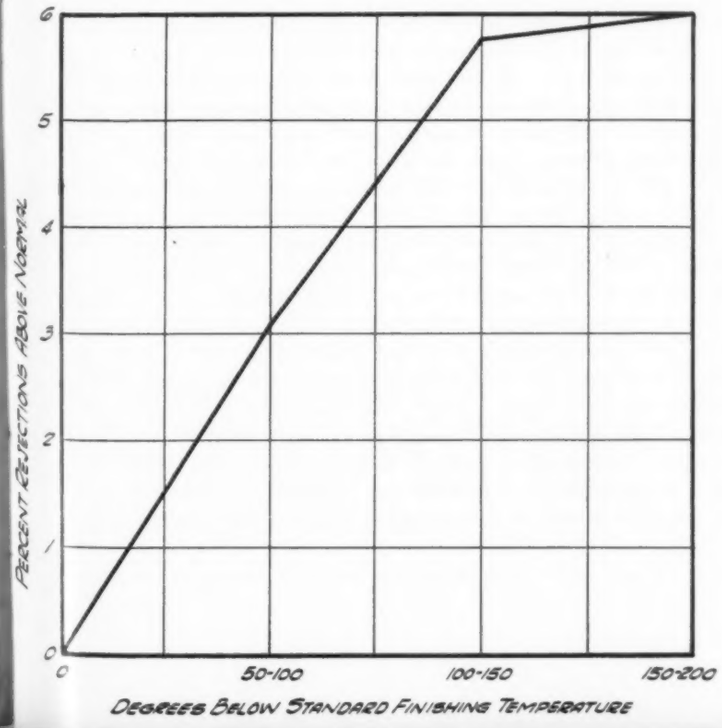
Figure 6—Effect of low finishing temperature upon chipping bed rejections.



into pits within the desired time limit. This mechanical change gave further beneficial results by increasing the available soaking pit space, improved blooming mill temperatures, and decreased billet rejections. It is only logical to assume that shorter cast to charge intervals will decrease the required time in the soaking pits. This is clearly shown in Figure 4. As the percentage of ingots charged in the lower desired time intervals is increased, that much more soaking pit space will be made available for other steel. Taking this a step further, Figure 5 shows the effect of the pour to charge and the pit time interval upon the heating performance. As these intervals are lengthened, the per cent of ingots rolled below the desired finishing temperature also increases. Figure 6 shows the effect of these lower finishing temperatures on chipping bed rejections. It will be noted that the rejections are increased appreciably with the lower rolling temperatures. By analyzing the factors affected by this mechanical change, we have found that rejections were decreased, which means increased shippable production was obtained.

In conclusion it can be said that the steel industry has made big strides in increasing its production since the national emergency arose. As long as this situation exists, the efforts and ingenuity of the individuals within this industry will be directed almost entirely toward problems of producing more and better steel for national defense. Under the pressure of this need, the bessemer process will assume more and more importance as a steel making process because of its flexibility, high rate of production, and relative independence of scrap supply.

5 *Mill Equipment . . . . .*

JOSEPH MALBORN, *Engineer*, United Engineering and Foundry Company, Pittsburgh, Pennsylvania

▲ I THINK I am safe in saying that very probably in no section of the steel industry has there been greater progress made over the past fifteen years than in flat rolled products section, in which section is included the new continuous and semi-continuous hot and cold sheet strip mills and plate mills, and in this category I am including all the 4-high hot and cold mills, single stand non-reversing cold mills, single stand reversing cold mills and the tandem cold mill trains.

To the older men who have spent upwards of half a century, or even more, in the sheet, tinplate and strip game, it seems only as yesterday when we felt we had turned out a real turn's work on the old tin mill if we made three tons, sheared plate, or if on 42 in. sheet mill we made four tons of 27-30x96, and well do I remember the sensation it caused around the old mill when on one turn on a 34 in. wide mill one roller actually rolled 12 tons of 16-24x72, truly it was the talk of the district.

Yet those phenomenal outputs represented a tremendous stride over the previous century and half or so, when before the introduction of the rolling mills, run by the old water wheel in every case up to the introduc-

tion of the steam engine, all sheet and tinplate was actually hammered out either by hand or by the old tilting hammer, also operated by a water wheel, and the output per fourteen to sixteen hour shift was reckoned in pounds, not in tons, because a ton was never reached.

We thought we had the world by the tail when we threw out the little old 20 in. and 22 in. diameter rolls running at about 20-25 rpm, and replaced them with 28 in. diameter rolls running at 28 rpm, and then when we raised the ante to 32 in. diameter rolls at 30 rpm we thought the management had gone daffy, because our tonnages crept up increasingly and we all wondered where the heck all the sheet and tinplate was going.

Then along came the Tipperary system at Vandergrift, (which was undoubtedly the father of the double mill system and the present mechanized sheet and tin mills) and we really thought we had arrived somewhere —but right at our back door was the continuous sheet strip mill being born, and that's only about sixteen years ago.

Well do I remember the day when I was called in by one of our big customers in the automobile game and was shown some .062 x 30 in. and .078 x 36 in. single pickle stock shipped to them from the first sheet strip mill and the inspector told me that in the whole shipment they had not found a sheet varying more than .003 in. and that it was going through the presses with practically no breakage, and the surface was as good, if not actually better, than anything we could produce on our old jobbing mills. Something else had arrived. I remember a bunch of mill men in one of our meetings in Pittsburgh saying, "Well it may be O.K. for sheets up to 36 in. wide in the heavier gauges, but they will never make 48 in. wide." You all know the ansewr to that wishful thinking; we are up to over 90 in. wide, and this may not be the limit, who knows? Over the past sixteen years we have made greater and more rapid progress than the previous hundred years, and what the next big move will be is probably now in somebody's brain.

Now, strange as it may seem to those who stand around and watch the world go by, without doing something about it, this remarkable progress in sheet and tinplate and plate, light and heavy, has reacted on us in more ways than one, and not all these ways have been for the real benefit of mankind in general.

Just take your minds back to the various wars fought over the past fifty years, and try to remember if, through the duration of any of them, the Spanish American war, the Russo-Japanese war, the Boar war, (mentioning only these three) you were ever called upon to do the almost impossible in the sheet and tin mills or in the plate mills. Were you bothered by the priority system, were you asked to cut down on your coal, light, power and the other things we are hearing about every day now, more and more? You were not.

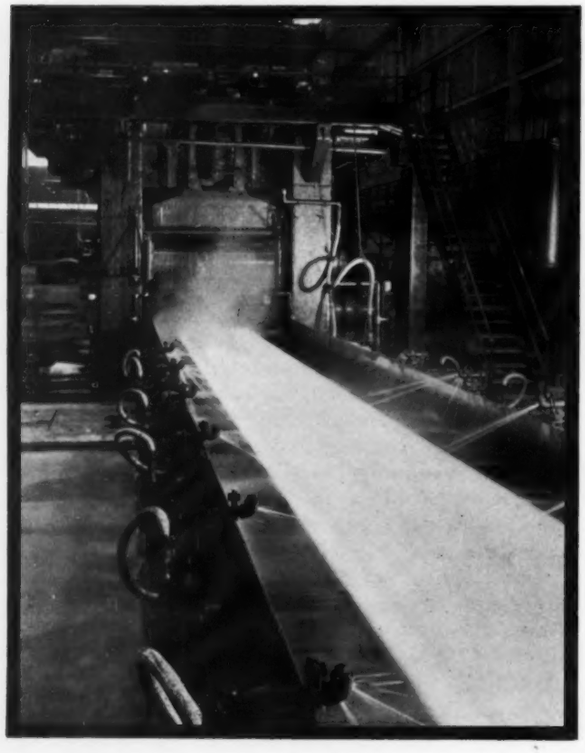
You never heard about such matters until the first World War of 1914-1918 was more than half way through, because real mechanical fighting was practically unknown before then. There were no panzer divisions in those previous wars, and we never heard of the German armies rushing through Belgium and France in motor trucks and tanks; we read time and again of the endless lines of marching troops tramping hour after hour, mile upon mile through the countryside of Belgium and France until they were stopped at the first Battle of the Marne in September 1914.

It was at this first Marne fight that we really first heard of thousands of troops being moved quickly by any mechanical means. You will remember how the French commandeered all the buses and taxis of Paris, and moved an army to the northeast of Paris and outflanked the great Von Kluck and turned the tide of battle and caused the retreat of the Germans from the Marne back almost into Belgium.

That was the real beginning of what is now termed "panzer troops", and two years later this was followed by the tank, and then war had really entered the mechanical age, and what material contributed more than any other towards this sorrowful and murderous era? Steel, of all things. Of course, the greatest uses of steel in wars up to this period of 1914-1918 was in artillery—small arms, shells and ammunition and other parts. All else depended upon manpower, flesh and blood, brains and brawn, and above all, guts.

We still need today all this manpower, but it seems to me that with the present unholy machines of steel, more brains and brawn and guts are needed than ever before in the world's history, and naturally and logically this mechanized war of today calls also for a greater supporting army back home to supply the steel so necessary for these mechanical juggernauts, and this is why the appeal is going out all over the country for

Greater progress has been made in the past 15 years in flat rolled production than any other section of the steel plant.



steel and more steel; and a great part of this steel is in the form of tinplate, sheet and light and heavy plate for the navy, the mercantile marine, the army and the airforce, for in addition to the tremendous growth in the size of the armies, we have now the submarine, the tanks and the airplane, and you all know what goes into these weapons—steel and more steel, in ever increasing quantities, and with ever increasing speed.

Now anyone in the steel game knows that it is an easy matter, providing one has the time, space and money, to increase production by installing additional open hearth and rolling mill equipment, but when none of these important elements are available, and yet the necessity for increased production grows more strongly every day, the only other thing left for us to do is to look very carefully over the equipment we already have in use and to try to get just a little more out of it every day.

I am not presuming to tell mill men how to run their business, but isn't it a well known fact that we get so thoroughly accustomed to our mills we are somewhat inclined to feel that there is nothing else we can do? Yet, one day something very special comes up, the sales have gone out and taken an order for something you have never made before, and at first crack you rave about it and tell the sales to go jump in the lake, but after a while you cool off a little and you set to work to see what you can do about it, and nine times out of ten you surprise even yourself by doing the job. That is a common occurence.

Today we need sheets and plate, light and heavy; we need cold rolled products, more than ever before; we need the extra equipment to enable us to handle bigger tonnages of all these commodities, and there is very little time available for us to install this badly needed equipment. The pity of it all is that some of this equipment was not installed long ago before the urgent necessity arose, as usual our hindsight is better than our foresight, and it will be ever thus.

Looking over the hot strip mills of all widths from 24 in. to the big 96 in. and 98 in. mills, we have extraordinary theoretical tonnage capacities available, but I seriously doubt if any single one of these plants have sufficient available space to handle the real capacity of the mill if the mill was run to anything near its full capacity, and unfortunately some of the plants do not have any more available space to install additional warehousing, finishing or shipping facilities. But this does not mean the operators of such plants can afford to sit back and do nothing about it, and I know they are not doing so. Careful attention to the handling equipment available, the finishing equipment and space available is absolutely imperative, and sometimes it is surprising how much more tonnage can be handled and stored around if an extra man or two are put around to watch these things. Complete cooperation between the operating men, the sales, and the customer can go a long way towards helping out in these situations to see that the customer does not expect the mill warehouse to be his warehouse. Nobody wants to offend a good customer, but today there exists the necessity for the material to be moving continuously and quickly.

Customers can be asked to cooperate by taking orders in multiple widths and lengths and doing some of the shearing to size themselves, and it may be surprising the help that can come from such cooperation, and if everybody will consider that the country and its needs come first, this cooperation will be there, I know.

Some of the plants have pretty good facilities for handling big tonnages, pretty well up to the capacity of the mill, but shearing and leveling equipment is pretty well up to the limit, but may it not be that we can take a few broader chances with this equipment by shearing and leveling just a little heavier material than the rating of the machine? I think we shall find that practically all the shears say for $\frac{3}{16}$ in., that shear could surely cut $\frac{1}{4}$ in. thick plate if the knives are kept in good shape and the machine kept in good trim, and this same idea applies all along the line for shears and levelers and other similar equipment.

From now on, and until the need for all this extra tonnage is over, it is safe to say that the maintenance and repair crews are going to be just about the busiest gang in any plant, not to mention their growing importance. Any mill manager knows that if equipment is kept in good running order there is less likelihood of breakdown, and this applies all down the line from the open hearth, blooming mill, soaking pits, reheating furnaces, rolling mill finishing and shipping.

The hot strip mills are going to be expected to roll heavier materials than ever before, and in increasing quantities, to help out the ever growing demand for plate, and undoubtedly this extra plate tonnage will have to come from the sheet tonnage.

Most of the bigger mills which can roll this plate tonnage (and in this tonnage I am including plate from $\frac{3}{16}$ in. thick to $\frac{1}{2}$ in.) are sadly limited in cooling bed capacity and subsequent handling equipment, and this brings up the subject of artificial cooling by air or water. Every operator knows that such cooling means are not as desirable as they would like; physical properties, flatness and surface qualities must be considered; but in spite of all our antipathy to some of these methods, it seems to me that the end justifies the means, and the users and fabricators of this plate must forego some of their rigid demands in this respect, and this applies also to the army and navy and mercantile shipbuilding, as well as to general construction purposes.

One of the greatest drawbacks to letting the plate mills and bigger strip mills run anywhere near their capacity is the small orders for 5 and 10 cent mixtures, as we call them, which are coming through every day. There is certainly one way to cure some of this trouble, and that is for shipyards and arsenals and other big users to carry a greater stock of larger plates, out of which they can themselves shear up many of these small orders for small sizes and very small quantities. Along this same line, something can be worked out for enabling the strip mills and plate mills to ship in multiple lengths a good portion of the lighter plate tonnages, say $\frac{3}{16}$ in. to $\frac{7}{16}$ in., and maybe even heavier.

Of course, if somebody suggested a pool system for all government plate orders, they are liable to be shot at dawn, but who can say it would not work. The British, French and Germans adopted the cartel or pooling system; they may be all wrong, but in each case the steel men themselves ran the cartel, and if it didn't work, they had only themselves to blame; but it did work.

Getting back to the strip mills and the need for

increased production, while we are waiting for the necessary additional equipment to enable them to handle these greater demands, I can only suggest again that about the next best thing is to see to it that every bit of machinery and equipment is kept in the best apple-pie condition, and the material kept moving from the plant to the customer. Broader chances will have to be taken with the equipment, and there is no doubt but what there is a lot of reserve power and strength in the background that has not been used yet.

Every plant should have careful plans worked out ready to install the desired equipment when the time and money become available, but in the meantime don't say it can't be done.

Looking at the cold mills, the same arguments apply. Many of the small cold mill units are losing a very considerable portion of their mill capacity from lack of decent handling equipment to feed the mill and to take away the finished coils. I have seen mills right here in the States, where over 40 per cent of the mill's output capacity is wasted for lack of simple handling and feeding equipment.

When I used to stand in some of the older mills in various parts of Europe and Great Britain, and see some of their antiquated mills and equipment, I used to think we here at home were so far advanced above those fellows over there that they would never catch up. On the Continent and Great Britain I saw the sheet mills actually rolling light plate 3/16 in. to 1/4 in. and even heavier—of course not in long lengths. I saw old tin mills turned over to rolling aluminum and duralumin sheets. We over here are blessed with the finest mills in the world and the greatest steel output in the country and the world's history. The country needs sheets and plate, particularly the latter, and it is available right now in greater quantities than is apparent on the surface. To get it we need additional steel capacity as well as equipment in some plants. If we all pull our own weight in the boat we can surprise ourselves and the world about what we can and are actually doing.

DISCUSSION

PRESENTED BY

JOHN EVERETTS, JR., *Engineer*, Blaw-Knox Company, Blawnox, Pennsylvania

E. K. MILLER, *Assistant General Superintendent*, Jones and Laughlin Steel Corporation, Aliquippa, Pennsylvania

L. E. RIDDLE, *Blast Furnace Superintendent*, Carnegie-Illinois Steel Corporation, Duquesne, Pennsylvania

M. A. MAYERS, *Coal Research Laboratory*, Carnegie Institute of Technology, Pittsburgh, Pennsylvania

RUDOLPH JANATA, *Special Engineer*, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania

L. E. FEISNER, *Assistant Superintendent*, 100 in. Plate Mill, Carnegie-Illinois Steel Corporation, Homestead, Pennsylvania

JOHN EVERETTS JR.: With reference to Mr. Riddle's paper, I would like to take a moment or two to clarify one or two points about dry blast and its application from the standpoint of the air conditioning industry.

Mr. Riddle seems to be very definite in his position that very low moisture content, a grain or less than one grain, seems to be the most advantageous point at which to operate dry blast. His indications are there is increase in capacity of approximately 12 or 15 per cent.

Mr. Miller in Cleveland gave a very excellent paper, showing increases of 14 to 16 per cent in a furnace when dry blast was operated at or above three grains, which appears recently to have been set as an arbitrary limit. The only reason that it has been set at this limit is due to the equipment that has been used; that is, straight refrigeration equipment with spray type washers.

Three grain corresponds to a dew point temperature of 40 F. In order to maintain this dew point, it is necessary to pass the air through a spray with water entering the spray chamber at approximately 35 or 36 F. It can readily be seen that to go to any lower temperature by means of a water spray method would involve a condition below freezing, which was exactly the condition that Mr. Riddle experienced in the old Gayley process when they tried to go down to one grain, which corresponds to a 15 degree dew point.

The brine pipes, which were then used, of course, frosted up similar to frosting which you get on an ordinary household refrigerator. In fact a temperature of 15 degrees is lower than that actually used in a household refrigerator.

Obviously then, if it is required to go below three grains, it is necessary to go to some method other than a straight refrigeration air washer system.

A year ago, the refrigeration air washer system and one system of chemical absorption were the only two that were offered to the steel industry for dry blast application. At present it is interesting to note that of the seven manufacturers offering dry blast equipment, five were offering equipment which could go below three grains and down to one or a half a grain. Of those five, one used straight refrigeration on a post compression system, one used a combination of refrigeration with a glycol absorber, and the other three used no refrigeration but used the absorption method by using glycol or certain brine solutions of lithium chloride, calcium chloride, and calcium bromide compositions.

This definitely indicates that the air conditioning industry is trying to do all it can to assist the steel industry in promoting this work for defense and increasing the capacities of their furnaces. The air conditioning industry, however, does not and cannot tell steel men at what conditions the air should be maintained going to the blowing engines. That is for you to tell us, and we will tell you how that can be done at a comparable cost.

We do, however, feel that we are in a position, through the Weather Designing Committee of the American Society of Heating and Ventilating Engi-

neers, to tell you from what conditions the system should be designed.

In our contact with a number of steel people, we have found that there has been quite a divergence in the recommended design conditions from which blast furnace air should be conditioned. One of the unfortunate things about weather is that the newspapers will report a maximum temperature and next to it a maximum humidity for the day, giving an idea that you might have 90 per cent humidity coincidental with a temperature of 98 or 99 F. outside. This is entirely erroneous. The maximum dew point, and I am speaking now of Pittsburgh, will occur at approximately ten o'clock in the morning. The maximum dry bulb temperature occurs between three and four in the afternoon, and the coincidental dew point with the maximum dry bulb is usually the lowest dew point of the day.

Therefore, when you consider specifications for dry blast equipment, you should separately indicate the temperature from which the air should be conditioned and the maximum dew point. Normally for Pittsburgh, the maximum temperature will not exceed 100 degrees dry bulb, and the maximum moisture content will seldom go above ten grains per cubic foot, which corresponds to about a 78 degree dew point temperature.

The cost of dry blast equipment of the various manufacturers is comparable for any type system. While the air conditioning industry has not had very much experience in the steel industry, it has had experience in other industries where there are far tougher conditions to meet as far as the air is concerned. You can therefore be assured that your problems can be handled practically, simply, and with very little difficulty.

E. K. MILLER: In August, 1940, I visited the Woodward Iron Company and at that time they had two of their three blast furnaces air conditioned and were considering air conditioning the third furnace. I found that the results at Woodward were very encouraging; they were increasing production and quality of iron was improved. When I returned to Aliquippa, I recommended to the Jones and Laughlin Steel Corporation that consideration be given to air conditioning a blast furnace at the Aliquippa Works to determine what benefits we could bet in the Pittsburgh district.

In the Birmingham district, the humidity varies from one grain of moisture in the winter months to as high as twelve grains in the summer months, and on some days in the summer months as high as thirteen grains but not on an average for a whole month.

Having personally operated blast furnaces in the Birmingham district for 16 years and knowing both northern and southern practice, I could see that quite a lot could be gained from air conditioning of blast furnaces in the Pittsburgh district.

Mr. Riddle has had more early experience with dry blast and I know he believes in it. However, he thinks we ought to go to one grain of moisture per cubic foot.

I cannot say how low one should go to get the maximum results, but we do know from our six months' experience, that we have definitely gained from 14 to 18 per cent in tonnage, or an average of 16.07 per cent for June, July, August and September, 1941, compared with the same months of 1940, and from April 2, 1941, when the air conditioning plant started operating, until October 1, 1941, the gain in tonnage was 12.15 per cent. I will say at this time that October's gain was still better.

There are many executives who say, "Improve the coke, beneficiate all raw materials." I will not argue on that point because I agree with them one hundred per cent. However, I will say there is much to be gained from improving your raw materials, but you cannot do this job in six months, and we need the increased tonnage as soon as possible.

In my opinion, Mr. Brown read a very good paper on the improvement of coke. He brought out some very important points on which I agree.

Mr. Johnson, of the Inland Steel Company, read a paper three years ago before the Association of Iron and Steel Engineers in Pittsburgh, in which he brought out that by better screening of coke in the stock house, he reduced his coke consumption 100 lb on their No. 5 blast furnace which had been recently built. In view of their results on this furnace, they installed the same screening equipment on all their other furnaces.

I personally visited their plant last October and found they made a definite reduction in coke sonsumption on all of their furnaces. I do not know off hand whether it was quite 100 lb on all of the furnaces, but it was on their new No. 5 Furnace.

Mr. Swartz, of Carnegie-Illinois Steel Corporation, Youngstown Plant, brought out a very important item in his paper that should bring additional tonnage without building additional open hearth furnaces and that is, watch very closely the delays on the open hearths. He told of some of the things they were doing in order to minimize delays.

There are a few more points I want to bring out about air conditioning of blast furnaces. Mr. Riddle made a statement that you could gain 12 per cent over a year. I do not think he is far wrong. We have actually gained in six months, beginning April 2, 1941, 12.15 per cent, that is, with three grains in the winter months and 3½ grains in the summer months. Mr. Riddle operated the Gayley system where they froze the air. They went down as low as one grain.

L. E. RIDDLE: Seven-tenths.

E. K. MILLER: If you look back to the history of air conditioning in the Gayley system, you will find that they made gains as high as 16 per cent in tonnage.

In a recent report, I stated that the maximum gain in tonnage may be made between two and three grains of constant moisture. This will have to be proven by other plants who are now installing air conditioning units which will allow them to go under three grains.

However, I will say that the three grain system will give a very definite increase in tonnage; in fact, it is better than I expected in the Pittsburgh district. In comparing our tonnage for the six months, we are better than 8 per cent compared to the whole of last year.

I will say this, that if any blast furnace in the north or south is operated with an air conditioning plant, they can make a definite gain and can increase their tonnage, as is being asked for during this national emergency. Air conditioning equipment can be installed in a very short time. If the equipment is available

from the manufacturer, it can be installed in three months.

There has been a lot of discussion as to whether or not air conditioning equipment could be justified in the Pittsburgh district due to having humid weather only four months of the year. I believe that Jones and Laughlin Steel Corporation will have definite figures by April 1, 1942, which will show what can be expected in the Pittsburgh district after one full year of operation with modern air conditioning plant. All the figures we have given out are very conservative because we deducted every pound of scrap that was charged in the blast furnace, in arriving at the percentage of increase in tonnage; we included furnace runner scrap, ladle scrap, and other scrap not produced by the furnace. The approximate average of the scrap charged in the furnace was 78 per cent iron and for every ton of scrap charged in the blast furnace, we deducted one ton of iron, which was 94 per cent iron, and this, in turn, penalized the total tonnage.

L. E. RIDDLE: Mr. Everett said I seemed to be very definite about moisture reduction to one grain being advantageous. My reason for this is that, uniformity of moisture and constant weight of oxygen in the air delivered to blast furnaces being necessary for maximum results, both can best be obtained by conditioning air to one grain in the Pittsburgh, Chicago and Lake districts where for over 6 months of the year the moisture in the air averages below three grains and during many days we have periods when the air contains below one grain of moisture. Most air conditioning systems can guarantee one grain just about as cheap as higher moisture. With three grain systems, in order to uniformly maintain this amount in the blast, it may be necessary to introduce steam into the air before delivery of it to the furnace. I think all practical blast furnace men should be opposed to introducing steam into the air delivered to the hearth of a furnace. Practical operators know how detrimental moisture from steam leaks in a blowing room or the small amounts of water introduced into the furnace are from other sources.

Mr. Miller's report on the gain in tonnage with their conditioned air was very pleasing to me as it confirmed many statements I have made concerning the advantage of the so called "dry blast." I agree with him that we still have the cry "improve our raw material first, then install dry blast as a further refinement in furnace practice." We have made great gain in material beneficiation in the past ten years and will continue to do so but I am glad he agreed with me that installation of conditioned air plants will give us increased iron production quicker. We must meet requirements of this defense emergency as speedily as possible.

Mr. Miller and I have previously discussed the minimum amount of moisture that is most beneficial, practical and economically maintained, and I agree with him that the half dozen air conditioning plants now being built that can guarantee one grain moisture in blast the year around will give us the answer and will leave no doubt in the mind of air conditioning experts as to what we will demand.

Some furnace men have been lead to believe that some moisture is necessary for complete combustion of carbon. The best scientific information I have been able to get states that only 1/3000 of a grain is necessary —a long way off from one grain that we have been talking about. I believe that if furnaces are burdened heavy enough to need all the available blast temperature we can get, combined with air without moisture, the furnace will take both and like it. The secret of using dry air is to make the furnace like it.

M. A. MAYERS: Mr. Brown and Mr. Riddle have emphasized the necessity of a supply of raw materials of a constant, high quality in order to assure maximum production of quality iron from blast furnaces. They have not, however, told us what constitutes high quality of raw materials. That this is not an idle or academic question is down by the questions concerning coke quality raised by a recent paper by Johnson. (H. W. Johnson, Am. Inst. Mining Met. Engrs., T. P. 1402; Metals Techn., December 1941.) If the quality of the raw materials were defined by objective tests, and the supply for any given plant were controlled at the required level of quality, the production of quality iron from that plant could be materially increased without additions to the plant.

In such a complex system as a blast furnace plant it is not easy to interpret tests of raw materials as significant criteria of their quality. A statistical method (M. A. Mayers, paper presented before a Joint Session of the Coal Division and Blast Furnace Committee, Am. Inst. Mining Met. Engrs., Annual Meeting, February 1941.) of obtaining such an interpretation for any plant has been described. Its application requires only that adequate operating records and test data on raw materials supplied during the past be available for analysis.

When the required levels of raw material quality have been determined by the results of such study, it is necessary to set up methods of statistical control (E. G. Olds, Preprint No. 26 for Annual Meeting, Am. Soc. Mech. Engrs., December 1941; W. A. Shewhart, "Economic Control of Manufactured Product," D. Van Nostrand Company, Inc., New York 1931.) to assure uniformity of supply of materials of the desired quality.

The labor involved in such an analysis as described above is quite extensive, but it is negligible by comparison with that required even for minor changes in equipment. In general, the work can be carried out by engineers familiar with the processes under examination, who are willing to study analytical methods in order to gain the use of a very powerful tool. In fact, the methods have already been applied in many plants; usually, however, to the steel-making operations; men trained in their use are, therefore, already available in the steel industry.

RUDOLPH JANATA: To the writer's knowledge no mention was made on two important phases in the production of steel: personnel and training problems, and tolerances.

In all departments of primary importance of the steel plants, a complete operating crew should be held in reserve for any emergency due to illness, accident or other unforeseen instances. This would relieve the superintendent from the worry on account of shortage of labor when needed, and increase the output of the steel plant. In each of the important departments of the steel plants, trainers should be kept to train workers continuously for the various jobs requiring skill. The

trainers, the trained men and apprentices would make the maintenance of machinery and tools an easy matter and possibly in the end the rise in costs due to increased pay roll might not be appreciable.

The prescribed tolerances should be carefully scrutinized in such a way that the necessary weight is kept to a minimum, i.e. that for instance on all rolled sections, the tolerances for thickness is kept rather on the minus side than on the plus side thus preserving steel. Where tolerances are not determined for close fits for interchange of parts, it should be clearly indicated so that the inspectors should not be in doubt whether to reject the product due to a slight excess of the tolerance, if yet, the function of the part is not impaired by it. Clearly specified tolerance would expedite the work of inspectors and a saving of time besides the saving of materials would result from this proposition.

L. E. FEISNER: These splendid papers indicate the study and application in the steel making departments to bring about greater ingot production. It is pointed out that the present rolling and finishing mill equipment could handle the present steel making capacity.

In making these points, the writer believes one point was not stressed sufficiently strong enough. That is the lapsed time between the time an ingot is poured until it reaches its goal as part of a ship, tank ,truck, tractor, air-raid shelter or any of the other multitudinous items involved in building our national security along modern mechanized lines.

Probably the most important, and yet the least discussed, is the scheduling and planning of the present day modern steel plant. Yet it is the heart of the mighty production expected and demanded of the steel industry today.

How can we bring about better scheduling and planning with our present steel plant equipment? There are several standards set-up for production control that deserve a thorough study which can be changed and will improve plant production. They are (1) study of steel analysis to bring about broader applications (2) a study of gauge tolerances, particularily plates, to bring about better scheduling and rolling by fewer gauge changes, and (3) a better understanding of a plants facilities before placing orders that may involve defense deliveries.

Steel allotments should be thoroughly studied before allocations are made to a customer. No customer should be allocated a given amount of steel, unless it has a definite delivery possibility, either by truck or in carload lots. No production department has sufficient space to hold finished material awaiting allotments of steel to make up into carload lots or truck shipments.

There is a decided possibility that a study of inspection standards will bring about quicker deliveries or inspections at a more desirable point than on a congested mill floor. The writer believes that some of the inspection requirements are very much out-moded and can be revised to aid the present necessity of increased production.

Much pride has been taken in the development of the modern continuous mill in the last decade. But it must be pointed out that this continuous operation has only been accomplished from a slab to a rolled section. Before steel reaches a slab form, its production is semi-continuous and after reaching a rolled section, it again becomes semi-continuous because of the finishing processes required. It is because of this that scheduling and planning are of such vital importance. The scheduling of the bessemer or open hearth furnaces in conjunction with the slabbing mills is in many cases the all important function in bringing about increased production and rapid shipments of finished material. Every effort must be made to control every function of the furnaces, pits and slabbing mills to bring about a continuous flow of slabs to the mills in shipable items. All finishing units must be scheduled to care for the production from the mills and must be tied in with the earlier scheduling and planning of the steel making departments.

This is not a new problem to the operating managers, but it has become a difficult one because of the requirements and demands placed on the steel industry by our national defense needs. Therefore, it is evident that what was deemed good scheduling and planning in the past, does not meet the present day demands. Too many individual department interests are sometimes considered rather than the broad plant program, which is the final program for completely improved production control.

A study of the proper places to assemble and hold material and to take minor yield losses will bring about an improved schedule. Too often steel is held in a finished condition awaiting shipment when it could and should be held in a semi-finished state, many times in slabs, often in ingots and of course at times should not have been scheduled at all. The cheapest and most economical place to hold material is in scrap, next ingots, then slabs and if necessary semi-finished and never fully finished.

In connection with scheduling and planning, it would be a very fine and also illuminating picture if more study by the scheduling departments was made of the plant delays. It will be found in many cases that a delay occurred because some department attempted to follow a schedule that had been poorly planned; yet the scheduling department probably never knew it caused the delay. Bad scheduling should show up on a delay report as well as a mechanical or electrical delay.

It may at times seem like sticking out one's neck, but there is no better way of improving practice and production that by a frank expose of the existing condition. Department heads are all concerned in their individual yields and cost controls, but it is only fair to admit that under our present emergency we should individually do our best for the common cause and finally let the all-out results obtained be the satisfaction expected.

Increased Production from

EXISTING BILLET HEATING FURNACES

By W. N. Horko, Furnace Engineer

HENRY DISSTON & SONS, INC.

Philadelphia, Penna.

Presented before A. I. S. E.
Philadelphia District Section

▲ SPEED, speed, and more speed! More and more production! These words have been ringing in the ears of all of us during the past year or more. Every day we see at first hand or hear of machines, mills and furnaces which are being taxed far beyond what was considered at one time to be their maximum production rate and still the cry goes on for more and more finished materials to fill the requirements of the stupendous all-out effort for our national defense.

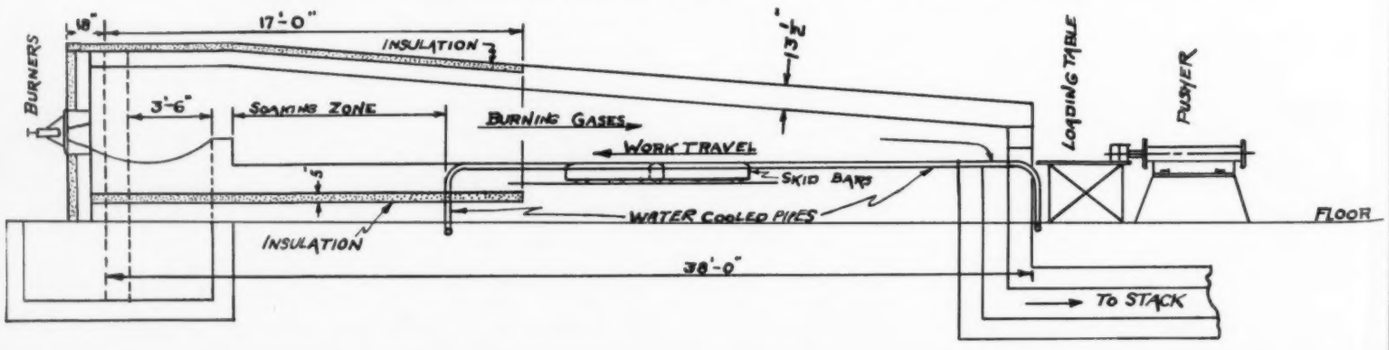
It is at times a little frightening to read of the billions upon billions of dollars which are being poured into this great effort and we as individuals may wonder how we fit into so stupendous an undertaking. Every day we read of one or more new plants springing up here and there at a cost of millions of dollars. Many of us may not be fortunate enough to have a hand in the planning, erection and operation of these new and modern plants. We may be relegated to the operation of the "old faithfuls" which have served us so well during the now rapidly fading era of peace. Day in and day out they operated and faithfully produced sufficient quantities for a world at peace. But now that the world is inflamed with the fever of war these "old faithfuls" will be called upon to do just a little better than they have been doing. Many of them are working now at the very maximum rate but in some cases it may be possible to increase their production by making a few changes.

This paper deals with the changes made in an old coal burning, smoke belching billet heating furnace which produced almost as much heat outside its walls as it did inside. This furnace was 38 ft long x 10 ft wide. It is a pusher type billet heating furnace serving an 18 in. hand bar-mill heating 4 in. x 4 in. billets of varying lengths and 2½ in. x 15 in. x 3 ft band saw slabs. (See Figure 1) It was coal fired and had a firebox 3½ ft long x 10 ft wide, which was located at the discharging end. The flue was located at the charging end and was connected to a stack. The work was pushed through by a pusher, having a cylinder 6 in. in diameter x 45 in. long and a piston of the inside packed type. It received water pressure from a central accumulator system at 600 psi. This pusher equipment gave a great deal of trouble due to water leakage. We were constantly repairing the operating valves and replacing packing around the pusher rod and in the piston. During shutdowns in very cold weather trouble was experienced from freezing.

The work traveled over water cooled skid pipes which were made from 2½ in. double extra strong pipes which were 23 ft long. These were unsatisfactory in that they were responsible for cold spots on the bottom side of the billets and also because they gave no warning before failure occurred.

A soaking zone 9 ft long with two discharge doors was located between the end of the pipes and the fire-box. Billets usually were turned over in this zone and held for several minutes in order to heat the cold spots resulting from contact with the cold skid pipes.

Figure 1—Sectional view showing general arrangement of pusher type billet heating furnace.



The furnace refractories consisted of 13½ in. of fire brick throughout with no insulation whatever.

It was very difficult to maintain a constant temperature in any part of the furnace with the method of firing used because when the fire-box was charged with coal the temperature went lower and lower and then as the coal bed gradually burned up, the temperature went higher and higher.

The furnace usually was operated with a positive pressure and the atmosphere was usually on the reducing side because of the smoky condition.

tioned, made from 2½ in. double extra strong pipe, 23 ft long. The replacement alloy skids are made in sections. Each section is 4 ft long x 1¼ in. thick x 7 in. deep, with 3 ft approximately 5 in. square and located 5 in. from each end and the middle. (See Figure 2) The bar is notched at each end at the bottom about ¼ in. in order to provide ample space so that each bar can freely expand over the foot of the adjacent bar. There are 36 bars in all, five in tandem and six across. As placed, each bar over laps the two adjoining bars about 6 in., giving a 1 in. overhang over the feet of adjoining

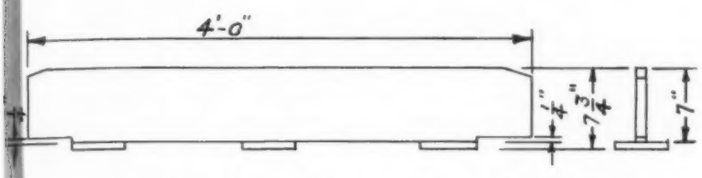


Figure 2—Sketch showing design of alloy skids used in furnace.

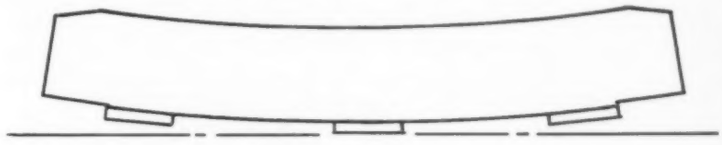
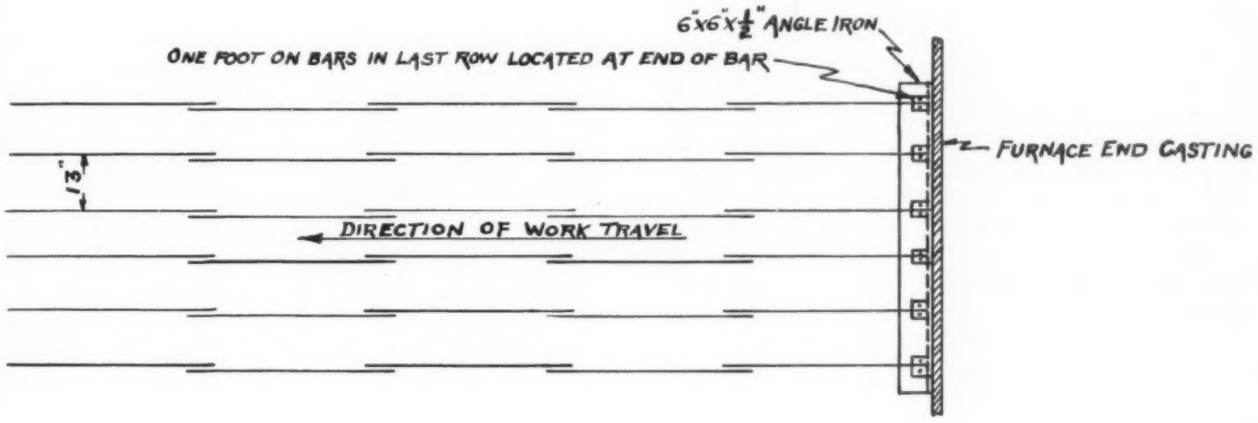


Figure 4—After a year's service, alloy skids warp as shown here, and must be straightened.

Figure 3—Plan view showing arrangement of alloy skid bars in furnace.



After a little study, it was decided that a few changes in the furnace construction would increase its heating capcity which in turn would increase the production of the mill it serves and incidentally, would improve the working conditions around the furnace and mill. Therefore, the following changes were made.

1. Replacing the water cooled skid pipes with solid alloy skids.
2. Replacing water pressure from a central system with a self-contained oil pressure unit located at the furnace.
3. Replacing coal fuel with oil.
4. Rebuilding 17 ft of the furnace at the hot end with 9 in. of high quality fire brick backed up by 4½ in. of insulation.

The water cooled skid pipes which were originally built into the furnace were, as has already been mentioned, made from 2½ in. double extra strong pipe, 23 ft long. The replacement alloy skids are made in sections. Each section is 4 ft long x 1¼ in. thick x 7 in. deep, with 3 ft approximately 5 in. square and located 5 in. from each end and the middle. (See Figure 2) The bar is notched at each end at the bottom about ¼ in. in order to provide ample space so that each bar can freely expand over the foot of the adjacent bar. There are 36 bars in all, five in tandem and six across. As placed, each bar over laps the two adjoining bars about 6 in., giving a 1 in. overhang over the feet of adjoining bars. Across the furnace the bars are placed on 13 in. centers in order to accomodate the short billets which are rolled occasionally. The last row of six bars, that is those at the charging end, are fastened to the furnace end casting. (See Figure 3) All the remaining bars are free to move. All the bars are bricked in to within 1 in. of the top, provision of course being made in the form of pockets for the expansion of the feet. Six expansion pockets are also provided at the discharge end in the hearth of the soaking zone. The two rows of bars, twelve in all, nearest the combusion chamber are of the analysis, 25 per cent Cr, 12 per cent Ni, while the remaining 24 bars are made from 30 per cent Cr and 3 per cent Ni. This latter analysis was selected at the colder end of the furnace because of its high abrasion resistant property. All bars are cast and not rolled sections.

These skid bars as a whole have been satisfactory. They decreased the coal consumption while the furnace was still on this type of fuel and eliminated the cold spots on the billet bottom, thereby eliminating the necessity of turning them over and holding them a few extra minutes in the discharge zone as was previously mentioned. They have also made possible a substantial saving in water pumping, since water was kept running all the time whether the furnace was in operation or not. These skids do, however, misbehave slightly in that they gradually become concave on top and convex on the bottom (See Figure 4). When they have taken this shape, after about ten or twelve months of service, the thinner band saw slabs which are only 2½ in. thick have a tendency to ride over each other at the skid joints, causing a pile-up inside the furnace and profanity outside. Even though these bars are made from a cast material, we have found it possible to straighten them after they have gone out of shape. This is done by heating to about 2100 or 2200 F and soaking them thoroughly. It is very important to soak thoroughly in order to avoid breakage. After the bars have been heated and soaked, they are laid flat on the furnace charging table and pushed with the furnace pusher against two 8 in. x 8 in. bars, laid one in front of the other across the end furnace buck stays. When performing the straightening operation, care must be taken not to push the skid bar after the temperature has dropped much below 2000 F, otherwise breakage will occur. So much for the skid bars.

The second change, namely the oil pressure unit for the pusher consists of a small tank holding about 25 gal of light hydraulic oil and on which is mounted the pump, pump motor and pressure regulating valve. The pump has a capacity of ten gallons a minute and is capable of developing 1000 psi. This 10 gpm capacity will move the pusher head at a rate of 7 fpm.

The original pusher cylinder was re-bored from 6 in. to 6¼ in. plus or minus. 005 in. diameter and a ring type piston was fitted into it. A new head was made to house the chevron type packing which seals the oil inside the cylinder at the point where the piston rod passes through it. This type of packing is very efficient and the oil leakage has been negligible.

The pusher is semi-automatic in operation. That is, a hand operated valve lever is thrown forward causing oil to flow into the cylinder behind the piston and moving it forward. When the piston has reached a predetermined forward position an operating dog attached to a side guide rail reverses the position of the valve lever. This action relieves the pressure behind the piston and also causes oil to flow in at the opposite end of the cylinder pushing the piston toward its original position. Just before this position is reached, another operating dog moves a second valve lever which unloads the pump and the piston comes to rest. This change has been very satisfactory from an operating and maintenance angle.

The third change, which was made simultaneously with the fourth change, to be mentioned later, was the introduction of oil fuel. The original combustion chamber for coal was 3 ft 6 in. long. It was thought advisable to increase this to 5 ft for the oil burning equipment. This was accomplished by pushing out the end of the furnace 18 in. It was also necessary to fill in the ash pit under the grate bars. This was done with old firebrick. The new combustion chamber bottom was curved between the end wall and bridge wall to present a smooth path for the flames without any sharp obstruction which might cause carbon formation and to lift the flame over the work.

Four 3 in. low pressure air-oil burners of a modern design, were placed in the discharge end wall on 18 in. centers and at a height so that the horizontal center line of the burners is 3 in. above the bridge wall of the hearth. The bridge wall is 10 in. high or 2 in. above a two high charge of 4 in. x 4 in. billets.

The total capacity of the four burners is 80 gal an hour. To date the maximum consumption has been 40 gal an hour with an average of 30. These consumptions included heating up. Air is supplied at 20 oz and oil at 30 psi. The furnace is equipped with an oil pressure regulating valve, strainers and an automatic oil shut-off valve which closes upon failure of either air or oil pressure and which must be manually reset. Provisions have been made for the installation of temperature recording equipment of the radiant thermocouple type. No automatic temperature control equipment is provided since it has been found that a furnace of this type will operate very satisfactorily without automatic equipment if the air and oil pressure is kept constant. It is now possible to operate the furnace under a positive pressure and hold the atmosphere neutral or slightly oxidizing.

The fourth change consisted of rebuilding 17 ft of the furnace at the hot end with 9 in. firebrick and 4½ in. of insulation in the walls and on the arch. We also added 5 in. of insulation to the hearth.

The changes which have just been described have made a great improvement in the production and in the working conditions around the furnace and mill. The average increase in production was 25 per cent and in one case, when large bands are rolled, the increased production is 40 per cent. This high carbon band material is more or less flash heated. That is, the furnace temperature is kept about 200 F higher than the required work temperature. With coal fuel, the heating rate was a great deal slower because the work was enveloped by smoke and the burning coal gases which shielded it from the radiant heat eminating from the sides and roof of the furnace.

The increased heating capacity just cited is due to the fact that the temperature gradient between the discharge end and the charging end has been greatly reduced due to the insulation, the reduction of heat absorption by the skids and the clear atmosphere produced by the oil burners. The charging end of the furnace is now about 1400 F while formerly it was in the black range.

The actual fuel cost per ton of steel produced is now about 30 per cent greater with oil than with coal, but when the cost of coal handling and ash removal is added to the coal cost, the oil cost is only slightly higher than the coal cost. This slight increase may seem objectionable. However, when we consider the fact that the production was increased 25 per cent and more with a minimum capital expenditure and with no increase in labor charges for the mill or the furnace, the slight increase in labor charges for the mill or the furnace, the

slight increase in fuel cost is justified and particularly at a time when the cry is for greater and greater production.

DISCUSSION

PRESENTED BY

A. J. FISHER, *Fuel Engineer*, Bethlehem Steel Company, Sparrows Point, Maryland

HOWARD HALSTEAD, *Assistant Fuel Engineer*, Bethlehem Steel Company, Sparrows Point, Maryland

C. M. THOMPSON, Henry Disston and Sons, Inc., Philadelphia, Pennsylvania

A. J. FISHER: I can verify the results of Mr. Horko in changing coal fired furnaces over to oil or gas, where production has been increased. With a little careful analysis in the change over by studying the related problems, as Mr. Horko has done, there is no doubt that the results will justify the effort many times over.

In reviewing furnaces, at the present time, in respect to speeding them up, we ought to realize that a study of the heat release, the Btu per cu ft of furnace volume, is of prime importance. You can start with a certain air temperature and a certain degree of mixture of the fuels and possibly be able to burn 30,000 Btu per cu ft of furnace volume, etc., but if you really want to speed up the furnace and make the refractories the limiting factor, it is possible to increase the heat release by preheating the air to a higher temperature, and by the degree of mixing of the fuels and air, so that in the end you might increase the heat release up to 225,000 Btu per cu ft. It appears to me that any furnace in which the production is to be increased should be attacked from the heat release angle.

Another point I would like to make at this time, which is not a point in Mr. Horko's paper, is that when you are studying a number of furnaces of similar design you can afford to spend a lot of time on one of those furnaces with the idea of making the changes on the others the same. The principal objective should be to develop one of those furnaces to its point of maximum efficiency and then at that time change all of the other furnaces so that they are exactly like the furnace that was originally changed. I believe there is an advantage of 5, 10 or 15 per cent in production by making all the furnaces alike. It gets all of the operators to thinking along the same lines, eliminates confusion, and gives them a new standard, a new plane, about which to talk and in which to work.

HOWARD HALSTEAD: I enjoyed Mr. Horko's paper very much. He showed that furnace production can be increased by a substitution of fuels. In this case, I think the relatively higher temperature and luminosity of the oil flame accounts for the increase in the rate of heat transfer to the furnace charge.

C. M. THOMPSON: Mr. Fisher touched on something I think is quite important, and that is simplification. Possibly what I am going to say does not apply so much to the steel mill as it does to the manufacturers. One of the worst bugaboos we have had in the saw industry has been the manufacture of thousands of special products—no matter what the customer asked for, we would make it. This emergency defense program has been a god-send to us in that direction. It eliminates the special products, and I would say in 70 per cent of the cases, we have found the customer could use the standard article, but he had been so in the habit of ordering something special, because he thought that was the only thing to do his job—and the manufacturers were foolish enough to go ahead and make it for him even though it up-set the program. I think a lot of man-hours can be saved by standardization of products; in other words, trying to point out to the customer the standard product that will do his job, and thereby eliminate a lote of unnecessary machine set-ups.

ASSOCIATION OF IRON AND STEEL ENGINEERS

ANNUAL SPRING CONFERENCE

MONDAY AND TUESDAY, APRIL 27-28, 1942

Hamilton, Ontario, Canada

MONDAY, APRIL 27 2:00 P.M.—Plant Inspection Trip. 6:30 P.M.—Dinner. 8:00 P.M. Technical Session.

TUESDAY, APRIL 28 9:00 A.M.—Plant Inspection Trip. 2:00 P.M.—Technical Session.

Headquarters: ROYAL CONNAUGHT HOTEL, Hamilton, Ontario

Inspection Trips are planned to two steel producing plants in the Hamilton district. An interesting technical program will be presented. It is believed that this meeting will do much to bring home to those attending the problems and efforts of the steel industries of Canada and the United States.

Increased Production from
EXISTING PLATE MILL EQUIPMENT

By A. F. Franz, Superintendent Steel Div.
ALAN WOOD STEEL COMPANY
Conshohocken, Pennsylvania

Presented before A. I. S. E.
Philadelphia District Section

▲THIS paper partially covers the reasons for the increased tonnage of our 80 in. plate mill. This mill is located at Alan Wood Steel Company, Conshohocken, Pennsylvania. The mill was built and put into operation in 1914.

The equipment consists of a slab storage yard with two overhead electric cranes suitable for handling hot or cold slabs, and slab ingots. In this storage yard the rolled steel slabs from the blooming mill, and slab ingots from the open hearth are carefully sorted, inspected, and prepared for the re-heating furnaces. The slabs are then loaded on narrow gauge cars and shipped into the furnace section of the mill.

Six side-door re-heating furnaces are located between the slab yard and the first roll stand. These re-heating furnaces are oil fired. Each furnace is equipped with six water cooled, pressed steel door frames, and doors. The water cooling system is of the open circulating type. Two electric charging machines handle the slabs and slab ingots to and from the furnaces. Two transfer tables convey the heated slabs to the first lifting table at the three high roughing stand.

The mill is an eighty-four inch, three high, tandem mill. It is driven by two 1600 hp motors. The speed of the motors is set and governed by liquid torque regulators. The top and bottom rolls are 30 in. in diameter when new. They are driven by herringbone gear reduction units. The middle roll is eighteen inches in diameter and is friction driven. It is raised and lowered automatically to position by hydraulic cylinders mounted on the roll housing. The counter-balance for the top roll is also hydraulically operated. Forged steel screws, 1¼ in. pitch, with brass nuts are used for the screw down. These screwdowns are driven by a 100 hp motor which is mounted on top of the gear reduction unit housing. The drive from the motor to the screws is through a steel worm shaft and bronze wheel mounted on top of the roll housing.

The roller tables on either side of both roll stands are of heavy construction. Disc type rollers are used. All rollers and side shafts are equipped with roller bearings lubricated by a forced feed system. The table rollers are motor driven and may be rapidly reversed through electric control panels operated by master controllers located in the operator's pulpit.

The transfer tables leading from the finishing stand rolls to the leveller have cylinder type rolls. These fifteen inch diameter rolls are driven by a steel worm shaft, and worm wheels on the ends of the rollers. This type table is also used in the shearing and shipping sections.

Two pumps, electrically driven, having a capacity of 240 gpm are used for the hydraulic service. These pumps are of the three plunger type. A 24 in. diameter, 15 ft stroke accumulator is connected to the system close to the pumps. The hydraulic operating pressure is 600 psi. The pumps are automatically operated by hatch-way switches, which in turn are actuated by the lowering or raising of the ballast tank attached to the accumulator cylinder.

The increased tonnage that it has been possible to roll in the past two years may be attributed to numerous mechanical improvements that have been made to the various operating equipment. Mechanical improvements which have directly, or indirectly, reduced the delays caused by breakdowns. Excellent cooperation existing between the operators, maintenance men, engineering, and management is another cause for better operating conditions. These factors increased the efficiency of the equipment thereby producing more tonnage at a conservative operating figure with lower maintenance cost.

An accurate record of all replaced parts is kept on file. Whenever a replacement occurs too frequently the causes are analyzed by the operating, maintenance and engineering departments. Immediate steps are taken to correct the design or change the type of material used. Each day a breakage or replacement report is made out by the department superintendent. This report states whether wear has been normal or subnormal, or whether failure was due to carelessness on the operators' part. In our opinion this report has played an important part in reducing careless and unnecessary damage by the personnel. It also gives the superintendent an accurate record of the careless employees. The personnel is naturally conscious of unnecessary damage and strive to keep their records clean.

The outstanding improvements and renewals recently made in the 84 in. plate mill department are briefly listed as follows:

The overhead electric cranes in the slab storage yard gave considerable trouble during the winter months. These cranes operating on an open runway are not protected from the weather. Snow, sleet, and ice would

form on the contact shoes and rails, slowing down the operation often causing furnace delays due to furnaces waiting for slabs to be charged. This difficulty was eliminated by changing the design of both the collector rail and shoe. A steel angle rail was used and so applied that the shoe made contact underneath instead of on top of the rail. This change has proven very satisfactory as no further delays from this source have been noted.

One of the two charging cranes in the furnace section was rebuilt to handle a 6500 lb ingot. The crane was originally built for handling a 3000 lb ingot. Faster charging and less maintenance has resulted from this change. All crane runway girders, rails and supporting brackets have been re-aligned and re-riveted. This assures smoother operation and longer life of track wheels and wheel bearings.

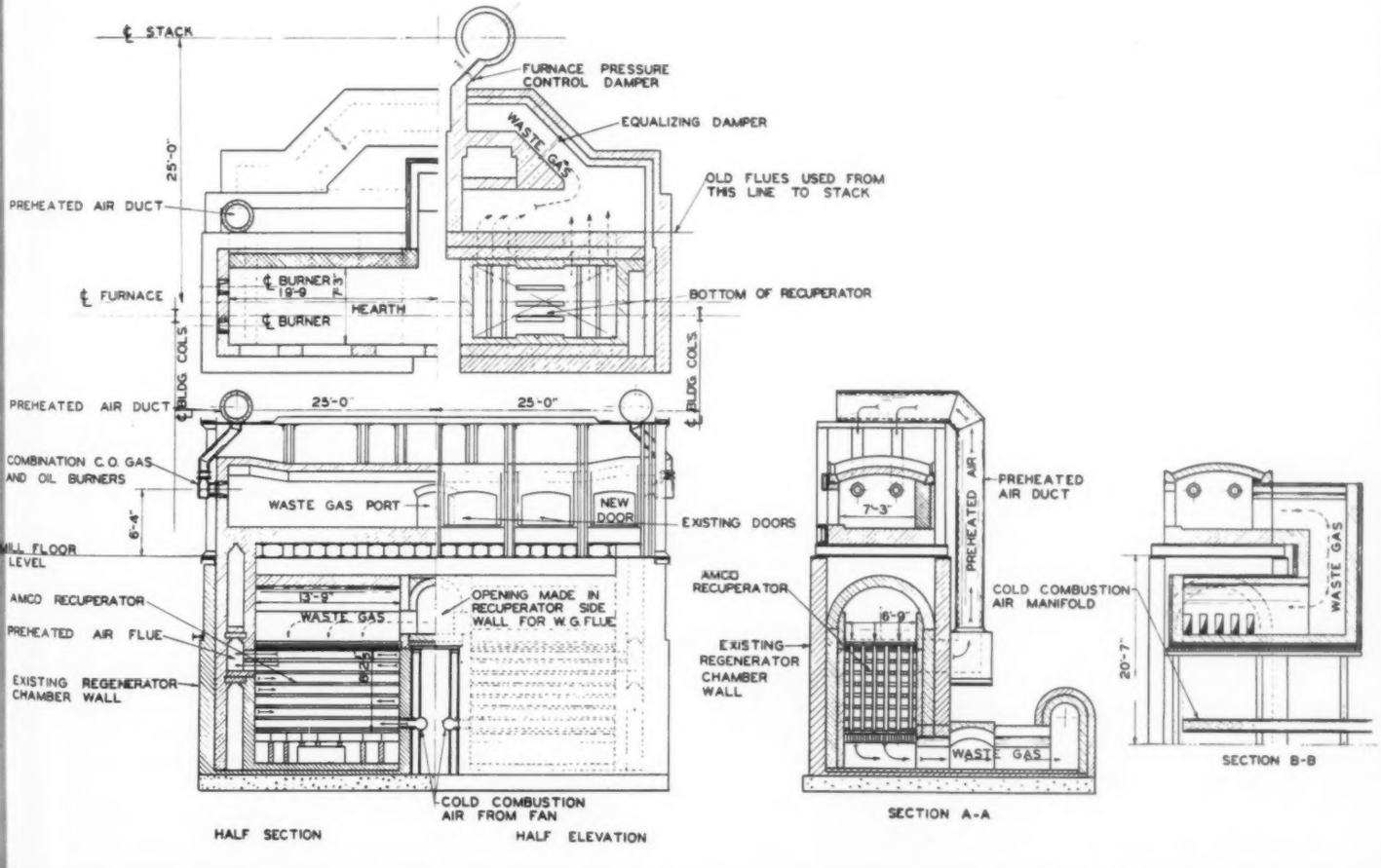
One of the re-heating furnaces has recently been changed to a recuperating type. Although the control and instrumentation is not completed, good results are being obtained. Other improvements to furnaces, such as increasing the width of the hearth, new type oil burners, better combustion practices, etc., have resulted in lower heating costs and fewer heating delays. The old type swivel joints formerly used on the water lines for cooling the furnace doors have been replaced with armored flexible hose. Water leaks and damaged brick work from these leaks have been eliminated by this change. Plastic refractory is now being used for lining the furnace doors, replacing the brick formerly used. The first doors lined with this material have been in constant use for a year and a half and appear as good as when installed. The Btu and time lost while frequently changing brick lined doors has thus been eliminated, and the efficiency of the furnace increased.

The housings of both gear reduction units on the mill drives have been rebored and an over-size babbitted bearing fitted to the top and bottom gear shafts. This new design bearing is so constructed that it is firmly held in the housing, thereby insuring proper engagement of the teeth. This fact prolongs the life of the gear and pinion teeth, as well as the babbitt bearing.

The top and bottom spindle carrier bearings have been changed from babbitt to a composition bearing. This composition bearing now gives approximately three times the life previously experienced with the babbitt bearing. With the present bearing less wear on the spindle necks is noticed.

A forced feed lubricating system has been installed to lubricate the roll bearings, spindle carrier bearings,

Sketch showing details of in-and-out reheating furnace for plate mill heating.



screwdown shafting, etc., on both the roughing and finishing stands.

The indicators which are used to set the rolls to the desired gauge of plates have been redesigned. Features incorporated in the new design make it possible to change the adjustment easily and there is less chance for the indicator to move from the setting. The increased accuracy of the indicator results in less roll damage and otherwise speeds up the rolling due to its positive action. Flood lights, whose beam is directed on the indicator, enable the screwman to get a better view of the indicator and its graduations.

The carbon steel wearing plates fastened to the roll housing windows have been changed to a special nickel steel. Records show that these special nickel steel wearing plates are giving four times the life of the carbon steel plates. This, of course, reduces the maintenance cost. The principal feature, however, is better alignment of the rolls in the housing.

The clutch arrangement on the worm screw-down shafts have been changed. This arrangment is used when leveling the rolls in the mills. Previous practice required the screwman to leave his position and walk out on top of the roll housing by means of a catwalk. From this position the clutch adjustment was made. The clutch is now adjusted from the mill floor by means of an extension lever. Time is thereby saved whenever it is necessary to make this adjustment during the rolling period.

In the past year improvements have been made to the middle roll lifting and operating mechanism. The 18 in. middle roll is raised and lowered between the top and bottom rolls as is customary on a three-high nonreversing mill. Hydraulic cylinders mounted on the roll housings furnish the power for raising and lowering the roll. A series of levers form the connection between the roll and the hydraulic cylinder. These levers have been made heavier and all pins and bushings were carburized to prevent wear. The hydraulic cylinder operating valve is now automatically operated by means of a cam connected to the table lift motors. This change is outstanding since the old type friction driven valve caused frequent mill delays.

The bronze bearings located in the ends of the lifting levers coming in contact with the roll ends have been discarded. A composition bearing is now being used. Records show ninety per cent greater life from the new bearings.

Wearing plates in the breaker box under the end of the screws have been changed. A high grade bronze plate was used to replace the old steel plate. The friction created due to great pressure at this point caused the steel disc to break. The new bronze plate is giving better service.

Dust protection bags have been placed over the exposed part of the threaded screws. The bag extends down to the bronze nut fastened in the housing. In this manner fine particles of scale thrown into the air are prevented from coming in contact or adhering to the screw, thus preventing excessive wear.

Improvements have been made to the roll changing equipment reducing the time formerly required for this work.

The lifting tables (four in number) located on each side of both the roughing and finishing stands have been extensively changed. These tables are raised and lowered to the upper and lower positions through shafting, links and levers operated by an electric motor. The tables are cushioned on the lower position by hydropneumatic cylinders located under the tables. The outstanding changes to the various parts of the tables are, as follows:

Wider seats in the girders for supporting the table roller bearings.

The teeth on the cast steel gears for rollers and side shafts are now being carburized to resist wear.

All pins and busings through the levers on the lifting mechanism have been carburized.

Cast steel disc type rollers are being replaced by a fabricated roller consisting of rolled steel discs welded to a high tensile steel shaft.

A new transfer table of sturdy construction with a forced feed lubricating system was built in our shop. The new table replaced one of lighter type, located at the approach of the leveler. The frame girders and bracing on the new table hold the driving mechanism in far better alignment. This increased the life of the worms, worm wheels, bearings, etc. The old table taken out of service caused many mill delays while costly parts were being replaced or repaired.

Improvements have been made on the hydraulic pumps which supply the hydraulic pressure for mill equipment operation. The expensive re-babbitting of the crankshaft and drive bearings has been discontinued. This was accomplished by boring the housings and inserting bronze bearings. Better alignment of the moving parts resulting from this change eliminated the excessive wearing of the gears.

The accumulator connected with the hydraulic system has a piston 24 in. in diameter with a 15 ft stroke. This accumulator was completely dismantled six months ago and a new highly polished piston installed. A new bronze guide bushing with a forced feed lubricating system was put in the cylinder. The bronze bushed packing gland was changed to the split type, making it possible to repack the cylinder when necessary without removing the ballast tank on top of the piston.

These changes on the pumps and accumulator have eliminated frequent mill delays previously experienced while repairs were being made.

Water mains throughout the mill have been renewed. This assures an adequate supply of water for the cooling of the rolls and roll necks. Twin basket type strainers were installed in the new mains. It is now possible to clean the strainers while the mill is operating instead of shutting the mills down as was the former practice.

The machining and assembling of roller tables and other parts is well under way in our mechanical shop. Upon completion this new, stronger equipment will be put into service.

The parts replacement records, previously mentioned, enable us to quickly spot equipment that gives excessive trouble. A thorough study then results in mechanical developments that are in line with the march of progress.

That the changes mentioned have proven worthwhile is a matter of record. The hourly production during the recent months has increased 16.8 per cent over the average for 1940, which was a representative year for

run of mill orders. Seventy per cent of this increase was accomplished by a reduction of mill delays due to heating. The other 30 per cent is due to a reduction of mechanical delays.

With the almost continuous operation of the mill and equipment, a high standard of maintenance has been maintained on a heretofore normal cost basis in spite of an increase in labor and material costs.

DISCUSSION

PRESENTED BY

N. C. BYE, *Chief Engineer*, Henry Disston and Sons, Inc., Philadelphia, Pennsylvania

W. M. WARDLE, *Superintendent*, Sheet Mills, Henry Disston and Sons, Inc., Philadelphia, Pennsylvania

H. H. ANGEL, *Electrical Department*, Bethlehem Steel Company, Sparrows Point, Maryland

W. G. WILSON, *Superintendent*, Plate Mill, Alan Wood Steel Company, Conshohocken, Pennsylvania

A. J. FISHER, *Fuel Engineer*, Bethlehem Steel Company, Sparrows Point, Maryland

A. F. FRANZ, *General Superintendent*, Steel Division, Alan Wood Steel Company, Conshohocken, Pennsylvania

N. C. BYE: I would like to ask what type of lubrication is used on the composition bearings on the spindle carrier, and if water lubrication is used, whether it is clean water or water which is possibly contaminated with a certain amount of dirt and silt.

In our plant, we use raw river water which is filled with a great deal of silt and foreign matter and we have had some trouble from this source. Where clean water is available, the lubrication problem has been much simplified. In view of our experience, I would be very much interested in how Mr. Franz takes care of the lubrication of this type of bearing.

W. M. WARDLE: Mr. Franz's mills, of course, are a lot different from anything we have, but I would like to know a little about his heating furnaces.

H. H. ANGEL: We have a 110 inch, 3-high plate mill at Sparrow's Point which was installed in 1917. In the last few years it has been operating at top capacity, and it has been possible to increase production by better organization and checking over the places which delay the continuous flow of steel.

Electrically, one of the big problems is to keep the two charging cranes running without delay. We have never had much delay on those cranes, but it is essential to get after those cranes every minute the mill is down, in order to find the weak spots which might cause delay.

W. G. WILSON: The same is done at the 84 in. plate mill at Ivy Rock. Every week end we check all motors possible and tighten up all bolts and nuts.

A. J. FISHER: I have a question to ask Mr. Franz. We all hear about "quality" plates, these days. My question refers to quality. How does Mr. Franz keep the scale pits out of his plates? In other words, how does he produce plates without scale marks or pits?

W. G. WILSON: It is granted that the 84 in. mill at Ivy Rock is a tandem mill, both stands 3-high, all rolls interchangeable, in roughing stand we use a special middle roll that is grooved and is a wonderful scale breaker and cleaner, however should the roughing stand be idle for a time we roll and finish on one mill and do not have any great trouble in cleaning the plates of scale, salt, steam and water from our hydraulic system (560 psi). Pitted steel is a very rare condition here.

A. F. FRANZ: A fibre bearing is used on top and bottom spindle carriers and has given very good results. Water is used from leads going to mill bearings. This water is taken from the river, and goes through two screens before going on the mill, these screens can only take out the heavy material, all silt goes through to the bearings. We do not have any serious trouble except when the leaves are falling and heavy rains wash refuse into the river, then we clean screens and water pipes frequently.

As to the question on heating furnaces, we have two recuperative and four regenerative type furnaces. We have been doing a lot of work on the furnaces and still have a lot to do. On the recuperative type, we have increased the hearth area and consequently the tons per hour increased. One of the leading delays was with the heating on the recuperative type with the fire at both ends, and we have been able to reduce the amount of cinder by a high percentage, and that is quite an item.

W. G. WILSON: We use lifting magnets all over the mill—on the shipping floor and on the shear side also, and we have very little trouble with them. We do not use the round type; we use the rectangular type, 15 in. x 52 in., but they are used at times, too, for bumper blocks in stocking.

A. F. FRANZ: Now, as to the steel pits: I was an open hearth man at one time and that question used to come up regularly. I think good heating will take care of most of the steel pits. We have very little trouble with this defect. At one time we had plenty.

N. C. BYE: Do you use salt or wet bags?

A. F. FRANZ: Use salt. About 60 per cent of our product is rolled from ingots, direct. It takes a pretty good piece of steel to stand up under the rough-rolling, and the proper heating answers the pit question.

Increased Production from

EXISTING ARC MELTING FURNACES

By G. O. Van Artsdalen

Superintendent of Maintenance

HENRY DISSTON & SONS, Inc.

Philadelphia, Pennsylvania

Presented before A. I. S. E.
Philadelphia District Section

▲ WITH the existence of the present emergency and the need for vastly more than the normal production of steel as well as other industrial commodities the manufacturers of new equipment have been hard pressed in supplying the necessary tools and equipment to produce the increased quantities required. In the steel industry where machinery is of the heaviest nature, deliveries appear to be the longest, so that while awaiting delivery, the operating man, in conjunction with the engineering department is forced to step up his production with the equipment that he already has in operation. Rolling speeds are increased, heating time is reduced, rerouting of production lanes are effected to eliminate lost motion and bottle necks and many other ingenious methods are used to obtain more tonnage in a 24 hr period than heretofore.

Electric melting equipment handling high grade alloy steels has not been excepted in this demand for greater production and while their schedules almost always are for 24 hr operation in normal times, many methods have been resorted to increase capacities, eliminate time consuming operation, reduce down-time for repairs and last but not least, produce more steel per kwhr.

A very important change made to two furnaces that the writer has had dealings with has been the use of a new furnace bottom material. The original material used was very carefully set on the bottom fire-brick lining and then a mild heat was applied from an oil burner. After heat had soaked through this base material for from six to ten hours, heat was applied with the arc by placing pieces of carbon on the bottom and drawing the arc between the electrodes and these pieces. After heat had been applied intermittently for a while, more bottom material was added and this was allowed to soak up some heat. This process was repeated time and again until the bottom materials had been properly sintered and fused. The entire process from beginning to end of burning in bottom consumed from 84 to 96 hr and very seriously cut into the production of ingots.

The new material that was experimented with and finally accepted was much more easily handled. No preliminary oil fire was necessary, but the material was placed in the furnace bottom in a somewhat plastic state, packed and rammed to the proper density, then the arc was applied. With careful heating, the bottom was completely seasoned and ready for the first heat of steel with but from seven to nine hours of preparation or approximately 10 per cent of the time consumed by the previous method. In addition to the savings in time effected, the new bottom material made available more space for scrap as its cross-section was one-third the cross-section of the former material used. With the changes to the bottom alone, steel produced in a 24 hr period was increased from 2750 lb per hour to 3700 lb per hour in a small furnace. With other minor changes to arches and jams these two furnaces were found able to produce 35 per cent more steel per heat than they had ever produced before. With the step-up in the amount of charged cold scrap per heat more time was consumed in hand-charging than before but this was inconsequential when the increased tonnage was taken into account.

This evil of time consumed by hand charging has been eliminated by many furnace operators by the addition of the necessary equipment and changes to furnaces for top-charging of scrap. This set-up is ideal both as a labor-saver and time-saver, but as it required the purchase of a quantity of new equipment with the attending evil of distant shipping dates as well as an extended down-time for changing over the thought of it as a present day improvement is put aside for obvious reasons. It would, however, reduce charging time from sixty minutes to five minutes and where five to six heats are tapped each 24 hr, four hours per day is saved or almost the amount of time that would be consumed by an extra heat.

I am not a chemist and have a very vague smattering of knowledge of the procedure followed in the chemical analysis of test samples sent to the laboratory at intervals before a heat is ready for tapping. Carbon determination and the determination of the presence and quantities of alloys take an appreciable amount of time and usually cause considerable delay of tapping time. Where carbon determination by the old method meant the burning of a sample at high temperature and the analysis of the oxides produced thereby one-half to three-quarters of an hour was consumed. Now with the use of a direct-reading carbometer, the percentage of carbon in a sample can be determined in three to five minutes. Likewise a new laboratory tool known as the spectroscope is used with a comparable saving in

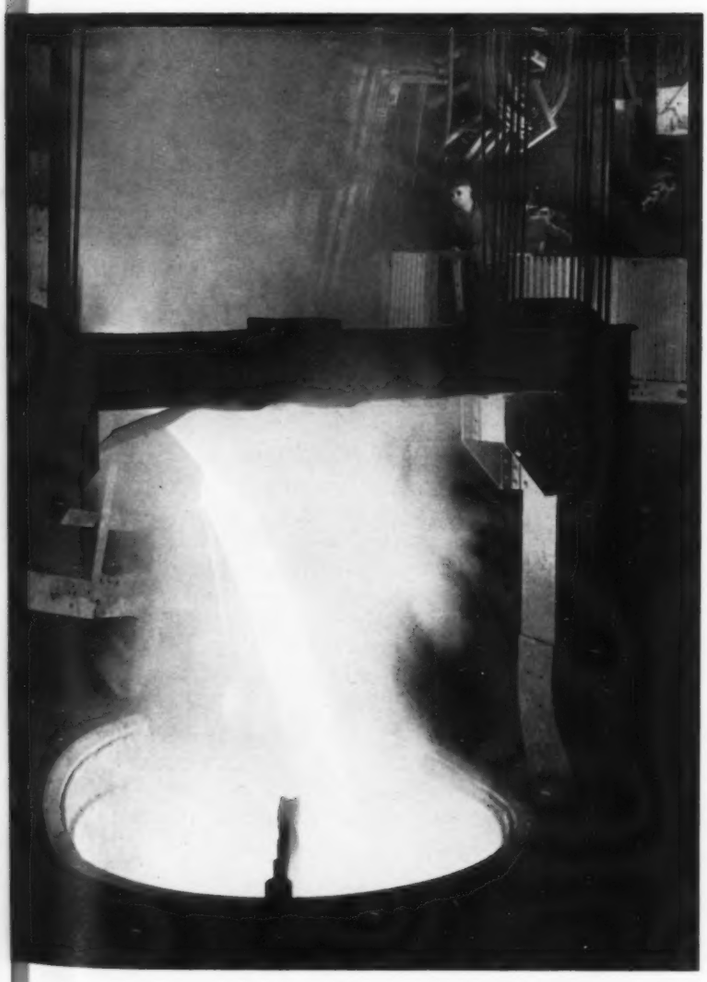
time for the determination of the presence and quantities of alloys.

The addition of a small routine laboratory to the melting shop used for running off prelims alone has materially helped in many cases to save time in analysis. An installation of a telautograph system very materially reduced the amount of time taken in communicating with the main chemical laboratory which in this case was located a distance away from the melting shop. This system also eliminated errors and misunderstandings as well as alibis.

With reference to handling equipment, the melting shop in question was serviced by one crane for two furnaces. Many times the tapping time was delayed until moulds had been set up, scrap cleared or heats stripped. With the addition of a new crane of 60 per cent more capacity and 15 per cent increased speed each of the two furnaces had its own crane and many of the beforementioned delays were eliminated. Needless to say, maintenance on the first crane was greatly reduced.

Another change made to reduce complications at tapping time was the redesigning of the tapping pit door, where the first method was to lift a section of the platform in front of the furnace out of the way with the crane and set it anywhere that space was available. This evil was disposed of with the installation of a balanced hinged door that is operated by the floor crew disposing of the necessity of the crane handling it at all.

The heavy demand for electric furnace steels has resulted in an approximate doubling of capacity in three years.



With the two particular furnaces in question sufficient transformer capacity had previously been installed. One possessed a tapped primary winding making a selection of voltages available. This was a decidedly beneficial feature as it has been proven that 195 volts on the electrodes will melt down cold scrap with a great saving of time while 145 or 105 volts are capable of retaining heat for refining or the working of slag. The other furnace is of smaller capacity and it was felt that the single voltage output of its transformer was no serious handicap as the transformer's capacity permitted higher current values at the electrodes.

Other electrical changes possible were quite in evidence, namely an increase of the control range and the increase of the size of conductors between the transformer and the furnace. The current transformers supplying control current to the contact-making ammeters were of the ratio of 6000 to 5 amperes. These were removed from the buss and replaced with current transformers having a ratio of from 8000 to 5 amperes which increased the current input to the arc by 3⅓ per cent. The only other change made to the control circuit was the removal of tapped coils in the contact-making ammeters. This was necessary because when the maximum current input was increased to 8000 amperes per phase the minimum current input was moved up in proportion to 2000 amperes which was much too high for refining. Untapped coils were installed which contained more ampere turns and the value of them was varied by bridging them with a simple rheostat.

The rigid copper buses carrying current from the transformer to the flexible conductors as well as those connecting the flexible conductors with the electrode holders were of sufficient cross section to withstand the increase of current but the flexible conductors themselves were barely large enough to carry the original current and had to be replaced. These cables had been in service for more than twenty years and it was thought best to replace them completely. Much trouble had been experienced in the past with the soldered terminals also and these were replaced with clamp type point contact terminals with silver inserts having added places for the additional cables necessary. Great ease was experienced in the installation of the new cables because of this new type of terminal and they are highly recommended by the writer, their additional cost being very much offset by the great savings effected in the time required for installation as well as a feeling of security being experienced in knowing that there is no solder to soften or run and that once installed further attention is unnecessary. Solderless terminals and connectors had been adopted previously as great time and trouble savers but this was the writer's first experience with any designed to carry such heavy currents.

Another decided improvement worth mentioning, and one that many furnace operators have adopted, was the change from carbon to graphite electrodes. The safe current density for the type of carbon used in furnace

electrodes is approximately 40 amperes per square inch while that of electrode graphite is of the value of approximately 170 amperes per square inch. The electrode size for graphite selected for the small furnace was such that it could carry 11,000 amperes safely without undue heating, was much smaller than the carbon electrodes and weighed but one-third as much. Joints in the graphite sections have increased conductivity, no difficulty whatsoever being experienced with them.

DISCUSSION

PRESENTED BY

F. C. SCHOEN, *Assistant Master Mechanic,* Midvale Company, Philadelphia, Pennsylvania

I. V. BLACK, *Superintendent,* Electrical Department, Bethlehem Steel Company, Bethlehem, Pennsylvania

G. O. VAN ARTSDALEN, *Superintendent of Maintenance,* Henry Disston and Sons, Inc., Philadelphia, Pennsylvania

H. D. ESTERLY, *Superintendent,* Electrical Department, Alan Wood Steel Company, Conshohocken, Pennsylvania

F. C. SCHOEN: I am interested in the material used for the furnace bottom, because there seems to have been quite a saving of time in burning in the bottom, over older methods.

L. V. BLACK: Our experience with electric furnaces parallels Mr. VanArtsdalen's very closely, particularly so with his experience in bottom making, that is, bottoms were originally built up with the usual refractory brick and dolomite, requiring a lenghty time to burn in the bottom. Present practice is to use a good refractory brick for the bottom, above which is packed or rammed a magnesium oxide preparation. With this method the "time out" for a furnace reline is greatly reduced over the past method.

Mr. VanArtsdalen mentioned the great time saved after converting his furnace over to top charging. Bethlehem has one 6-ton furnace constructed for top charging; it certainly can be charged with a minimum of time. In addition to the 6-ton furnace there is a 25-ton and two 50-ton furnaces. These furnaces are built for front door charging using the same charging machine that charges standard open hearth furnaces in line on the same floor. These electric furnaces cannot easily be rebuilt for top charging.

Overall time for charging any furnace is a matter of vital importance to the production schedule. Much depends on the nature and quality of scrap used, and should be given considerable study. Scrap in the nature of large bulk and low weight will require excess time in charging and often requires back-charging to get the required tonage into the furnace. This also necessitates two melt-down periods for the heat resulting in high kwhr per ton and loss of production per day.

Any company so enviably situated as to have at its command sufficient good clean scrap of proper charging sizes and known composition to completely charge the furnace on the initial charge, and at the same time have a minimum of voids in the charge, is in a position to establish records on production and kwhr per ton. The operation then resolves itself in to one of charge, melt, and tap. Charging a furnace with the common run of scrap of unknown composition requires numerous test samples on which chemical analysis must be run, to insure correct final chemical composition. Waiting for laboratories to analyze test samples is a costly delay to production schedules.

To minimize the delay in waiting for test analysis, we have installed a telautograph system and a pneumatic conveyor system between the furnaces and laboratory. The results are very satisfactory and have eliminated the delay in transportation of test samples, and also the errors in transmitting analysis by phone.

One other method of reducing furnace production delays at Bethlehem has been the addition of inspectors who are repairmen of technical experience. Their duties are to continually inspect and examine the furnaces, electric circuits, protective devices, all electrical equipment, oil systems, water systems and operating procedures. All work of this preventative maintenance and inspection is recorded as well as suitable notations as an aid for future studies and improvements. A fair estimate on the curtailment of production delays chargeable to mainenance of furnace equipment and accessories since the inspectors were added is 60 to 70 per cent of the previous time lost.

A very interesting factor in the operation of the furnaces is the fact that the load on the 25 cycle system has grown so tremendously that we are in a position of not having sufficient generated plus purchased power to supply the growing demands. For that reason, negotiations were made to convert the arc furnace operation from the 25 cycle to a 60 cycle supply involving a new 25,000 kw 60 cycle double circuit line from the utility company. Included also is a 20,000 kw condenser installed near the furnaces to eliminate "flicker" on the utility system as much as possible. The furnaces are scheduled to be put in operation on the 60 cycle system sometime around the end of 1941. It will be very interesting to observe any differences in operation between the two systems.

Upon investigation with the manufacturers of the various pieces of equipment used with the furnaces, it was found that extremely few changes were involved. Transformers could be used on 60 cycle without any alterations, but currents are to be reduced 30 per cent on the highest amperage taps, or melt down period. As these taps are only used during a portion of the melt down period, which again is less than half of the time for the heat, an actual reduction of input to the furnace will be less than 10 per cent.

Analysis of the 60 cycle supply shows a dependable source, available for maximum demands at all times, whereas under the present connections the furnaces must be shut down at times for power contract demand reasons. Therefore there is every reason to believe that with the new connection the furnaces will produce more tons per day at a more favorable power consumption per ton.

One other method of increasing furnace tonnage is

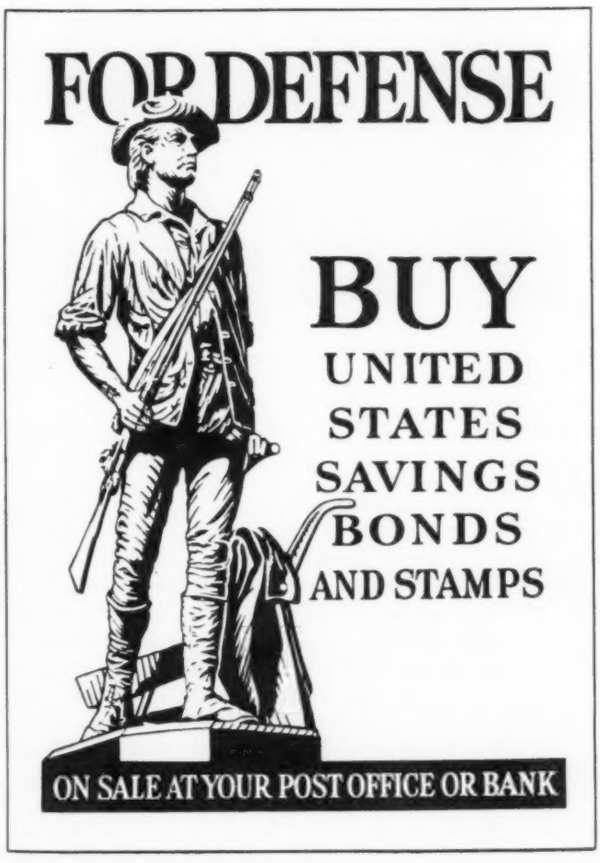
that of eliminating surges and the small incremental lengths of time that the electrodes are not in touch with the furnace charge or bath. To solve that problem, a special control has been added which produces a high speed operation to raise the electrodes when excessive loads are encountered during melt down or when the electrode touches the bath during the refining period. This high speed raising prevents much of the electrode breakage, carbon contamination, and rapidly clears the electrode of excessive load peaks, the result being that the normal effective melting circuit is restored in a minimum of time. Results since the installation of this special circuit has proven that it has been a timely and well-earned piece of apparatus.

G. O. VAN ARTSDALEN: I have a few more things to add to what Mr. Black said with reference to the bottom material. Our original bottom material was magnesium oxide, which we more or less compounded ourselves, I believe, and the new lining still has as its base magnesium oxide with several other ingredients added.

Mr. Black brought one thing to my mind which I had neglected to mention, that is, the addition or maintenance of spare parts to eliminate or shorten lost time. We have not found it possible to carry too much in the way of spare parts, because the spare parts are large and expensive, but we carry spare electrode holders and also spare electrode motors. We began to get into motor trouble now and then, and it seemed to run in bunches. We found that carrying spare coils or armatures still caused delay so when we purchased spare motors we simply made them easier to change by connecting them to a flexible armored cable with a 4-pole attachment plug, and all of them are so connected that any one motor can be taken down and the spare motor installed, which now takes but about 15 minutes as against 2 hours previously.

H. D. ESTERLY: I would like to know the kwhr consumption per ton of the furnaces.

G. O. VAN ARTSDALEN: That is a widely variable figure, especially when you are melting different types of steel. I think the best we have hit is 650 kwhr per ton. It depends on the difficulty you have with some of the alloys, and it depends on the size of the heat. Our heats range, on a 6-ton furnace, from 14,000 to 20,000 lb, and the more you cram into the furnace the more you can get out for a given number of kwhr. I think that it is impossible to answer that question unless you are referring to one particular type of steel.



A. I. S. E.
District Section Meetings

CHICAGO, FEBRUARY 10
"Air Raid Precautions for Industrial Plants", *Col. F. L. Gray*

CLEVELAND—YOUNGSTOWN
FEBRUARY 16, 17
"Lightning Phenomena",
G. D. McCann

PHILADELPHIA, FEBRUARY 7
"Alloy Steel Cladding", *H. S. Blumberg*, and "Welding Nickel Monel and Inconel Clad Steels",
W. G. Theisinger

PITTSBURGH, FEBRUARY 10
"Substitute Coatings for Tinplate",
C. E. Brown

Some Aspects of the PROPOSED STEEL EXPANSION PROGRAM

By Arthur G. McKee, President

ARTHUR G. McKEE COMPANY

Cleveland, Ohio

Presented before A. I. S. E.

Cleveland District Section

ARTHUR G. McKEE

▲ SOMETHING over a year ago, Gano Dunn was asked to make a report on the nation's steel capacity and requirements. He reported that there would be a surplus of productive capacity above what was required for the armament program and for ordinary consumption. This conclusion did not meet with the approval of certain governmental agencies, and a revised report by Mr. Dunn subsequently showed that requirements would be more than originally estimated, and that capacity and requirements would practically balance. Again, a lack of agreement—and finally a decision to increase steel capacity by ten or fifteen million tons per year was announced.

A glance at the various estimates prepared in connection with this work is interesting. Table I shows information condensed from W. A. Hauck's memorandum of September 20, 1941. Present ingot capacity is indicated to be 89,000,000 tons per year, with 99,000,000 tons projected for 1943 and 104,000,000 tons for 1944. Increases are also proposed of 6,508,950 tons per year of pig iron capacity and of 9,800,000 tons per year (25 boats) of lake ore carriers. While ingot capacity of 1942 may be 89,000,000 tons as indicated by the report, it is my opinion that actual ingot production for 1942 can be but little more than 80,000,000 tons due to the lack of a supply of steel scrap and pig iron.

Table II gives the figures prepared by R. C. Allen and advanced November 11, and indicates a marked shortage in blast furnace capacity rather than in ingot capacity. This table also includes Mr. Hauck's statement regarding bessemer and open hearth increases.

Another set of data, prepared by Harry Bourne, is shown in Table III. Here again a deficiency in blast furnace capacity is projected.

Table IV is the expected production of pig iron, ingots, and steel for castings, and the expected consumption of pig iron, purchased scrap, and Lake Superior iron ore for the year 1941. Steel production (based on nine-months figures) is 83,000,000 tons; pig iron, 55,800,000 tons; pig iron consumed (estimated on seven months), 55,400,000 tons; purchased scrap consumed (estimated on seven months), 27,200,000 tons; Lake Superior ore consumed (estimated on nine months), 83,100,000 tons; and Lake Superior ore consumed in Canada (estimated), 2,000,000 tons.

Table V is a statement for 1942. Pig iron production for 1941 is expected to be 55,800,000. The furnaces now under construction, which will be running in 1942, should produce 2,875,000 tons more, and we should have 58,675,000 tons of pig iron available in 1942. The deficiency in the amount of purchased scrap is given at 5,000,000 tons, having been variously estimated from 4,000,000 to 8,000,000 tons. It will take 5,556,000 tons of pig iron to replace that scrap. The net shortage of primary metals in 1942 will be 2,681,000; additional synthetic scrap, if a fifty-fifty mix is carried in the open

hearth, will be 4,249,000 tons; estimated production of steel for 1941 is 83,000,000 tons, which, with the expected shortage of 2,360,000 tons due to shortage of primary metals, would give an estimated steel production, according to our figures, of 80,640,000 tons for 1942, which is a long way short of 99,000,000 tons. There is also an analysis of the iron ore situation, and of the coke situation.

Table VI is a similar tabulation for 1943. Assuming all the additional blast furnaces are in operation at the beginning of 1943, then you have 55,800,000 tons as of 1941, 7,567,000 additional capacity for 1943, making a total of 63,367,000 tons of pig iron for 1943. The deficiency in the amount of purchased scrap will be 5,000,000 tons (or more). To replace that figure, 5,556,000 tons of pig iron will be required. Then you

TABLE I

Estimates of Steel, Pig Iron and Lake Ore Carrying Capacities and Projected Capacities from Mr. W. A. Hauck's Memorandum to Mr. W. S. Knudsen

Time	*Steel capacity in net tons* *Added capacity*	*Total capacity*
Present		89,000,000
Initial, 2 years	10,000,000	99,000,000
Additional, 3 years	5,000,000	104,000,000

Increases in pig iron and lake ore carrier capacities	
Pig iron	6,508,950
Lake ore carriers, 25 boats	9,800,000

TABLE II

Estimates Cited at the Armistice Day Meeting of October 31, 1941

Mr. A. D. Whiteside's estimates of steel production:

Year	*Net tons*
1941	84,000,000
1942	82,600,000
1943	86,000,000

Mr. R. C. Allen's estimates regarding pig iron, ore, and steel outputs:

	1942	*1943*
Pig iron shortage	6,400,000	9,800,000
Steel output	83,000,000	86,000,000
Steel capacity	87,000,000	93,000,000
Iron ore	84,860,000	90,000,000
New blast furnaces required		32

Mr. W. A. Hauck's statement regarding new bessemer, synthetic scrap and steel capacities:

Capacity increase	*Approved*
Bessemer	2,600,000
Ingot capacity	6,500,000

TABLE III

Estimates of Pig Iron, Steel and Ore Carrier Capacities and Productions for 1941, 1942 1943 from the Bourne Report

	1941	*1942*	*1943*
Expected steel production	83,000,000	79,110,000	85,060,000
Pig iron required	55,400,000		
Expected pig iron production	55,800,000	58,110,000	64,060,000
Purchased scrap required	27,200,000		
Purchased scrap available	27,200,000	21,000,000	21,000,000
Lake Superior ore required	83,100,000		
Lake ore carrier capacity	87,400,000	89,200,000	97,100,000
Steel making capacity	86,149,000	89,149,000	89,149,000
Shortage of pig iron and scrap for steel capacity		10,000,000	4,089,000

TABLE IV

Expected Production of Pig Iron, Ingots and Steel for Castings and Expected Consumption of Pig Iron, Purchased Scrap and Lake Superior Iron Ore for the Year 1941 in Net Tons, from the Bourne Report of October 31, 1941—Short Tons

Steel production (estimated on 9 months)	83,000,000
Pig iron production (estimated on 9 months)	55,800,000
Pig iron consumed (estimated on 7 months)	55,400,000
Purchased scrap consumed (estimated on 7 months)	27,200,000
Lake Superior ore consumed (estimated on 9 months)	83,100,000
Lake Superior ore consumed in Canada (estimated)	2,000,000
Lake ore carrier capacity	89,500,000
All rail ore	1,200,000

TABLE V

Estimate in Net Tons of Pig Iron and Steel Production in 1942 and of the Amounts of Ore, Coke, Coking Coal and Scrap Required and Facilities Required, Based on Certain Data from the Bourne Report

Pig iron, purchased scrap and steel	
Expected pig iron production of 1941	55,800,000
Expected increase in pig iron capacity by 1942	2,875,000
Total expected pig iron production of 1942	58,675,000
Deficiency in amount of purchased scrap	5,000,000
Pig iron required to compensate scrap deficiency	5,556,000
Net shortage of primary metals in 1942	2,681,000
Additional synthetic scrap required	4,249,000
Estimated steel production of 1941	83,000,000
Expected steel shortage due to shortage of primary metals	2,360,000
Estimated steel production in 1942	80,640,000
Lake Superior iron ore	
Lake ore used in 1941	83,100,000
Additional Lake ore required in 1942	4,165,000
Total Lake ore required in 1942	87,265,000
Lake ore carrying capacities 1941	90,700,000
Canadian requirement	2,000,000
Capacity available to supply U.S.A.	88,700,000
Additional carrier capacity for 1942	1,680,000
Total ore carrying capacities in 1942	90,380,000
Surplus ore carrying capacity in 1942	3,115,000
Coking coal and furnace coke	
Additional furnace coke required	2,530,000
Additional coking coal required	3,800,000
This would require about 400 additional coke ovens.	

TABLE VI

Estimate in Net Tons of the Pig Iron and Steel Productions for 1943 and of the Amounts of Ore, Coke, Coking Coal and Scrap Required and Facilities Required, Based on Certain Data from Bourne Report

Pig iron and steel	
Pig iron produced in 1941	55,800,000
Additional pig iron capacity for 1943	7,567,000
Expected pig iron production of 1943	63,367,000
Deficiency in amount of purchased scrap	5,000,000
Pig iron required to replace scrap deficiency	5,556,000
Plant scrap from 2,620,000 tons of ingots	655,000
Factory scrap from 2,620,000 tons of ingots	262,000
Net excess of primary metals	2,928,000
Steel output of 1942	80,700,000
Additional steel in 1943	2,600,000
Estimated steel output in 1943	83,300,000
Additional synthetic scrap to be produced, vessels (11)	5,564,160
Iron ore and carrier capacity	
Lake Superior ores consumed in 1941	83,100,000
Additional lake ore required in 1943	10,934,300
Total lake ore required in 1943	94,034,300
Lake ore carrying capacity in 1941	88,700,000
Additional capacity available in 1943	8,675,000
Total carrier capacity in 1943	97,375,000
Surplus carrier capacity available in 1943	3,340,700
Additional ore required from other sources in 1943	1,929,000
Coking coal and furnace coke	
Additional requirement of coke in 1943 over 1941	6,660,000
Additional coking coal required in 1943 over 1941	10,100,000
Additional coking facilities required 1070 ovens.	

TABLE VII

Estimate in Net Tons of the Amounts of Pig Iron, Iron Ore, Furnace Coke, Coking Coal and Scrap and of Certain Facilities, Required in Producing an Additional 10,000,000 Tons of Steel. Based on Certain Data from the Bourne Report.

Steel production in 1941	83,000,000
Additional future steel production	10,000,000
Total future steel production	93,000,000
Pig iron used in 1941	55,400,000
Future deficiency in amount of scrap	5,000,000
Pig iron required to compensate scrap deficiency	5,556,000
Pig iron required in making 10,000,000 tons of steel	7,660,000
Total additional pig iron required	13,216,000
Total future pig iron production	68,616,000
Plant scrap from 10,000,000 tons of ingots	2,500,000
Factory scrap from 10,000,000 tons of ingots	1,000,000
Additional pig iron producing facilities required 33 blast furnaces	11,630,000
Total additional coking coal required	17,500,000
Additional coking capacity required 1,850 coke ovens.	
Additional Lake iron ore required	19,097,200
Additional Lake ore carriers 49 Maritime Commission boats	
Additional iron ore required from other sources	3,370,000
Additional "synthetic scrap" required	8,447,400
Additional scrap blowing facilities required 14 bessemer vessels.	

have additional scrap (from the additional steel produced) totaling 655,000 tons and 262,000 tons. Thus, there will be a net excess of primary metals of 2,928,000 tons. A final steel output for 1943 is estimated as 83,300,000 tons of ingots, and to keep a balance of fifty-fifty pig iron and scrap in the open hearth furnaces, you would have to have eleven additional bessemer vessels to produce 5,564,160 tons of synthetic scrap.

There is an important item that must not be overlooked. The additional requirement for coke in 1943 over 1941 is 6,660,000 tons, requiring over 10,000,000 tons of additional coal, and additional coking facilities of 1,070 ovens.

From the information that has gone ahead we have made up Table VII. Steel production in 1941, 83,000,000 tons; additional future steel production, 10,000,000 tons, making 93,000,000 tons. This is less than indicated by Mr. Hauck's figures. Pig iron in 1941 is 55,400,000 tons; future deficiencies in amount of scrap are 5,000,000 tons. It will take 5,556,000 tons of pig iron to replace the 5,000,000 tons of scrap, and to make 10,000,000 tons of ingots will require 7,660,000 tons more. Thus, you are going to have a total increase in pig iron requirement of 13,216,000 tons. The total future pig iron production is 68,616,000 tons; plant scrap from 10,000,000 added tons of ingots, 2,500,000 tons; and increased factory scrap, 1,000,000 tons. This will require, as against the present capacity, the building of thirty-three blast furnaces. Additional coke required, 11,630,000 tons; total additional coking coal, 17,500,000 tons; and it will take 1,850 coke ovens to produce that.

All this will require 19,097,200 tons more iron ore, and it will take forty-nine boats to transport it. Additional iron ore required from other sources, 3,370,000 tons, which will have to come in from Cuba, Chile, and the West and the South. It would take 8,447,400 tons of synthetic scrap to keep a fifty-fifty charge, which would require 14 bessemer vessels, 25-ton capacity, and maybe some of those 25-ton vessels will have to be split in two in order to take care of the making of synthetic scrap in two or three plants, because there will be more plants than fourteen that will require synthetic scrap, and you cannot very well deliver hot metal to the bessemer plant over in the next state.

At various times during the past six months I have conferred with some of the government representatives working on this question of steel plant expansion and have attempted to point out some inconsistencies in the program. I do not believe that we can produce as much steel in 1942 as in 1941, due to the scrap shortage clearly indicated. Likewise, the proposed increases in capacity mentioned for 1943 are practically impossible of attainment.

On the other hand, it is my firm conviction that not all of our existing equipment is being used to best advantage. Greater production can be obtained in many instances, perhaps at some sacrifice in operating efficiency, but nevertheless giving us the all-important production.

In the course of my contacts with the Washington agencies, I was requested to check the steel plate situation and the plate mill capacity. It was very difficult

to find figures as to the plate requirements for 1942, but an estimate of 8,500,000 tons was finally forthcoming. Plate mill capacity is as shown in Tables VIII and IX, giving annual totals of 2,235,000 gross tons of universal plate and 4,622,650 gross tons of sheared plate. In addition, according to the best information available, the wide strip mills (48 in. and over), with their present equipment of shears, levelers, etc., can roll 3,210,000 tons of plates up to ½ in. or more thick (Table X).

Furthermore, strip mills over 24 in. wide and up to 48 in. can roll 4,873,000 tons of intermediate plates, and there is a capacity of 2,996,500 tons of narrow plate material from mills under 24 in. wide. There is a lot of plate for ships and tanks that can be taken off these smaller mills. Disregarding the narrower mills, however, our plate mill capacity may be taken as shown in Table XI. In these figures, 35 per cent was deducted for scrap, etc., and the capacities, converted to net tons, total 5,177,000 tons of sheared plates, 2,500,000 tons of universal plates, and 2,327,000 tons of plate from the wide strip mills. Thus, we have a total plate production possibility at the present time, with present equipment, of over 10,000,000 tons, as against the expressed requirement of 8,500,000 tons.

The ten million tons of steel plates are easily available only if a central scheduling board is established, to which all of the orders for steel plates would be sent. Experienced steel men should make up that board, experienced in plate production and scheduling. Each order, each plate, should be allocated to the particular mill which should roll that particular plate, so that the

TABLE VIII

Universal Plate Mills
Estimated Capacities

Company	Location	Mill rolls, in.	Plate width, in.	Capacity in gross tons per year
Bethlehem Steel Company	Sparrows Point, Maryland	84	60	150,000
Bethlehem Steel Company	Seattle, Washington	22		14,500
Bethlehem Steel Company	Johnstown, Pennsylvania	67	36	120,000
A. M. Byers Company	Ambridge, Pennsylvania	96	90	32,000
Carnegie-Illinois Steel Corporation	Farrell, Pennsylvania	88	82	150,000
Carnegie-Illinois Steel Corporation	Gary, Indiana	38		100,000
Carnegie-Illinois Steel Corporation	Homestead, Pennsylvania	88		204,000
Carnegie-Illinois Steel Corporation	South Chicago, Illinois	60		160,000
Carnegie-Illinois Steel Corporation	South Chicago, Illinois	67		160,000
Carnegie-Illinois Steel Corporation	Youngstown, Ohio	43		400,000
Central Iron and Steel Company	Harrisburg, Pennsylvania	50		75,000
Colorado Fuel and Iron Company	Pueblo, Colorado			8,000
Inland Steel Company	Indiana Harbor, Indiana	24	20	40,000
Inland Steel Company	Indiana Harbor, Indiana	45		100,000
International Harvester Company	Chicago, Illinois	24	20	40,000
Jones and Laughlin Steel Corporation	Pittsburgh, Pennsylvania	45	40	100,000
Lukens Steel Company	Coatesville, Pennsylvania	66	48	70,000
Republic Steel Corporation	Warren, Ohio	42		100,000
Tennessee Coal, Iron and Railroad Company	Fairfield, Alabama	110		11,800
Weirton Steel Company	Weirton, West Virginia	54		100,000
Youngstown Sheet and Tube Company	Indiana Harbor, Indiana	42		100,000
				2,235,300

TABLE IX—Present Plate Mills for Sheared Plates—Estimated Capacities

Company	Location	Mill size, in.	Plate width, in.	Capacity in gross tons per year
Alan Wood Steel Company	Conshohocken, Pennsylvania	84	76	100,000
Allegheny Ludlum Steel Corporation	Brackenridge, Pennsylvania	110	102	85,000
American Rolling Mill Company	Ashland, Kentucky	58	52	11,500
American Rolling Mill Company	Butler, Pennsylvania	48	44	
American Rolling Mill Company	Middletown, Ohio	80	76	
Bethlehem Steel Company	Sparrows Point, Maryland	114	108	140,000
Bethlehem Steel Company	Sparrows Point, Maryland	160	152	200,000
Bethlehem Steel Company	Lackawanna, New York	79	72	30,000
Bethlehem Steel Company	Johnstown, Pennsylvania	134	128	150,000
Carnegie-Illinois Steel Corporation	Homestead, Pennsylvania	86	80	65,000
Carnegie-Illinois Steel Corporation	Homestead, Pennsylvania	141	140	225,500
Carnegie-Illinois Steel Corporation	Homestead, Pennsylvania	100	96	720,000
Carnegie-Illinois Steel Corporation	Gary, Indiana	160		200,000
Carnegie-Illinois Steel Corporation	South Chicago, Illinois	96	90	720,000
Carnegie-Illinois Steel Corporation	South Chicago, Illinois	90		120,000
Central Iron and Steel Company	Harrisburg, Pennsylvania	126	120	100,000
Central Iron and Steel Company	Harrisburg, Pennsylvania	89	83	40,000
Crucible Steel Company	Pittsburgh, Pennsylvania	24	20	16,900
Henry Disston and Sons, Inc.	Tacony, Pennsylvania	80	72	5,000
Inland Steel Company	Chicago, Illinois	103	97	100,000
Jessop Steel Company	Washington, Pennsylvania	76	70	3,350
Jones and Laughlin Steel Corporation	Pittsburgh, Pennsylvania	128		150,000
Knoxville Iron Company	Knoxville, Tennessee			900
Lukens Steel Company	Coatesville, Pennsylvania	204	200	210,000
Lukens Steel Company	Coatesville, Pennsylvania	140	134	
Lukens Steel Company	Coatesville, Pennsylvania	112	108	90,000
Lukens Steel Company	Coatesville, Pennsylvania	84	80	65,000
Otis Steel Company	Cleveland, Ohio			75,000
Otis Steel Company	Cleveland, Ohio	152		
Otis Steel Company	Cleveland, Ohio	77	72	45,000
Pine Iron Works	Pine Forge, Pennsylvania	96 & 84	90 & 80	22,000
Republic Steel Corporation	Youngstown, Ohio	84 & 60		150,000
Republic Steel Corporation	Gadsden, Alabama	22 & 90		168,000
Sheffield Steel Corporation	Kansas City, Missouri	66		11,500
Tennessee Coal, Iron and Railroad Company	Fairfield, Alabama	110		160,000
Worth Steel Company	Claymont, Delaware	160-120		228,000
Youngstown Sheet and Tube Company	Youngstown, Ohio	110		215,000
				4,622,650

mills will be working at as near maximum capacity as possible.

Take the big plate mill of the Carnegie-Illinois Steel Company at Homestead. There is a mill that should roll 100,000 tons a month. I understand its production is considerably less, because, on that big mill that should be rolling wide, heavy plates all the time, a lot of "cats and dogs" are rolled.

We need a capable, central scheduling board, free from any political pressure, to decide where we will make what and where it goes. Someone must schedule this production and not let it run wild. This problem is far simpler than most people think. This country can and will make all the steel plate that is needed to supply the demand as stated by the OPM, if it is properly allocated and distributed.

Constructive thought in the steel industry and by men experienced in the industry, if accepted and properly applied by the government agencies, can help the whole program tremendously.

TABLE XI

Summary of Plate Producing Capacities for 1942

	Long tons per year	Short tons per year	Plates available for 1942 if wisely specified and scheduled
Sheared plates	4,622,000	5,177,000	5,177,000
Universal plates	2,235,000	2,500,000	2,500,000
Strip mill plates	3,200,000	3,580,000	
Strip mill plates reduced by 35%		2,327,000	2,327,000
			10,004,000
According to telephone statement by Mr. Whiteside steel plate requirement for next year is			8,500,000

TABLE X

Estimated Potential Capacities Plate and Strip Long Tons

Company		Mill width, in.	Plate width, in.	Present total annual strip tonnage	Type of plate material	Plate capacities per year if provided with additional equipment	Plate capacity with present equipment
Great Lakes Steel	1	96	90	720,000	Soft plates 3/8"	400,000	400,000
Bethlehem (Lackawanna)	2	79	72	720,000	1/2" or less	400,000	400,000
Bethlehem (Sparrows Point)	3	58	52	600,000	5/16" soft	300,000	100,000
Jones and Laughlin	4	96	90	750,000	1/2"	400,000	400,000
Republic Steel	5	98	92	800,000	3/4"	500,000	500,000
Otis Steel	6	77	72	500,000	5/16"	300,000	100,000
Youngstown Sheet and Tube (Youngstown)	7	79	73	650,000	3/8" or less	400,000	300,000
Youngstown Sheet and Tube (Indiana Harbor)	8	54	48	700,000	3/8" soft plate	300,000	100,000
Armco	10	80	74	670,000	None	300,000	
Wheeling Steel	11	66	66	840,000	None	400,000	
Carnegie-Illinois (Gary)	12	80	74	700,000	5/16"	400,000	250,000
Carnegie-Illinois (Irvin)	13	80	74	640,000	5/16" soft steel	300,000	100,000
Weirton Steel	14	54	50	650,000	None	300,000	
Inland Steel	15	79	73	700,000	5/8" or less	400,000	400,000
Inland Steel	16	44	40	600,000	5/16" and less	300,000	100,000
Ford Motor	17	66	60	600,000	1/2"	300,000	
Granite City Steel	9	90	84	470,000	3/4" and less	200,000	60,000
				11,310,000		5,900,000	3,210,000

Narrow mills not included in above.

Mills over 24" up to 48"	4,873,000 tons
Mills under 24"	2,996,500 tons
	7,869,500 tons

Most of these narrow mills could produce considerable tonnages of plates when and if provided with cooling beds, levelers, shears, etc., which could be installed in a comparatively short time and at a low cost as compared to the installation of new plate mills.

DISCUSSION

PRESENTED BY

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E. M. SOARES: I do not have many things to say about this big problem, but I have a word to add to what has been said here. That is that we in Brazil are making a considerable effort to help in the present emergency. We have increased the production of our manganese ore mines. We have increased the production of a few of our chrome ore mines. And we are trying now to increase the production of our iron ore mines.

We have a very difficult problem in Brzail. It is principally a problem of transportation. Our iron ore is about 350 miles from the coast, in a very hilly region, and we have to transport the ore to the coast, to our ports, crossing two divides. We need rails and rolling stock. We do not have the rails and the rolling stock that you have in this country. We are trying to get more now, and we are improving the railroad so we can help more, as we wish to help.

K. D. TRUE: Our problem is somewhat connected with this problem presented. We are in great need of certain grades of steel and the situation in general will undoubtedly become worse. It is one of the things that has hindered the program as far as the ordnance department is concerned. Our job is to purchase all the material for the armed forces. That means tanks, guns, ammunition, etc., and it means a large tonnage of steel. Thus, we are vitally interested in increased production and in what Mr. McKee has said. It may be that he is right in his assumptions that this cannot be accomplished to the extent and amount anticipated.

The only thing we can see is the correct scheduling of mills. Of course, you have all heard of priorities. We issue many certificates every day in the ordnance department. It apparently was the ultimate aim of Mr. Stettinius when he was given that position in Washington, to start a system which would insure material going to the most vital points. This presents many difficulties, but we must admit that at least partial scheduling has been accomplished. Our machine tool men have been one of our most important customers on priorities so far. We all hope that we can continue to obtain the material as it is desired by everyone.

E. C. McDONALD: As operators, largely, I feel it is our responsibility to get the most out of the furnaces and mills we have. I was under the impression the meeting might take a turn in that direction but apparently the discussion is not going along those lines. However, I would like Mr. McKee's opinion on the present vogue of dry blast for increasing production of blast furnaces. If some of the claims for the equipment are valid, blast furnace production could be increased the equivalent of several new furnaces.

ARTHUR G. McKEE: Some twenty or twenty-five years ago, Mr. Gayley started in on dry blast, and he sold licenses for $100,000 per furnace, the licensee to pay all costs and take all chances. All of those plants were scrapped in a very short time, although the first ones showed remarkable increases in tonnage and decreases of coke consumption and what not. When the present campaign for dry blast started, all the old arguments that were used in the previous dry blast campaign were put into circulation again.

While some reports of dry blast installations give extremely interesting and actually fascinating figures, other installations show much lower figures. It is yet to be proved that you can increase production 15 per cent and reduce coke consumption appreciably. It is my sincere hope that the most optimistic figures may be realized.

G. E. STOLTZ: Since we are the largest producer, and can produce as much as the Axis powers together, I think Mr. McKee certainly put his finger on our problem, when he said all we have to do is organize what we have. That will mean that we will have to do without many items such as refrigerators and automobiles.

I think the country will have to approach this problem somewhat as it is being approached by our own company. We have certain plants, where the normal production is largely defense work, particularly steam turbines for ships. Our motor plants are very busy providing motor and control equipment for all types of manufacturing used in defense work.

We have one plant that has been utilized to make motors for washing machines and similar equipment. That manufacture has been greatly reduced, and we are now producing generators for airplanes by the thousands. Another plant is starting to work on small

circuit breakers to be used in airplanes. Still a third plant that has been making refrigerator bodies and electric ranges now is diverting its effort to the manufacture of body parts for airplanes.

M. D. HARBAUGH: I suppose you might be somewhat interested in my affirming that the Lake Superior iron ore supply is adequate to all the requirements of the lower lakes blast furnace capacity now in the picture, plus the added capacity which will be available next year. We expect consumption of lake ore this year, for the 12 months ending May 1, 1942 when the next shipping season is generally considered to begin, to be something like 78,000,000 gross tons. And at the rate of iron ore shipments thus far this year, there will be brought down from the Lake Superior district somewhere between 80,000,000 and 81,000,000 tons by lake, plus about 1,000,000 tons all-rail. So there is no question about the iron ore supply for the current year. That leaves a surplus of two or three million tons of addition to stocks to carry over to next year.

At the present time there are five new boats building that will come into service next year, which will add about 1½ million tons to the fleet capacity during 1942 and about 2½ millions thereafter. If it is possible to ship a million and a half tons more next year than is being shipped this year, and if there is a carry-over of two or three million tons from the supplies of this year, and the consuming capacity next year for lake ore, as indicated by Mr. McKee, is not to exceed 84,000,000 or 85,000,000 gross tons, the supply and requirements for iron ore just about break even. There is possibly some further capacity in the Canadian ore boats that has not been exhausted, which serves as a small safety factor against bad weather. So we feel pretty sure that the iron ore supply is adequate to the requirements for the year beginning May 1, 1942.

As to 1943, there are sixteen additional boats to be built by the Maritime Commission, some of which have been started. All are expected to come into service in 1943. These, plus the five now building for 1942, will add additional capacity of nearly eight million total tons for the 1943 season above the present fleet capacity, and nearly 9 million tons thereafter. So far as now appears, this probably will be able to take care of the additional blast furnaces which will actually be available by that time. Mr. McKee has told you there are about fifteen blast furnaces that are planned to be completed sometime during the next year and a half, but many of them have not been started, and the longer the time that elapses before they start, the more remote becomes their period of entry into service. Hence, it appears that our minds can be more or less at ease regarding the iron ore supply for 1942 and 1943.

As to this proposed 10 million tons increased steel capacity, and the ore requirements for it, the Lake Superior iron ore industry doesn't seem to be particularly concerned with it at the present time, because it seems so far removed from the probable realities. To provide iron ore for all the blast furnaces that are or can be in the picture by 1942 and 1943, seems as much as it is necessary to be concerned about just now, at any rate.

I might add something on a subject that has been given a lot of thought by a good many in this industry recently, and that is the shortage of scrap and what to do about it. We are told by officials in Washington that there probably will be six to eight million tons less of purchased scrap available to furnaces in 1942 than has been available in this year; in other words, 21,000,000 net tons or less of purchased scrap next year compared to about 27,000,000 tons this year.

If that is true, and it seems to be, what can be done about it? According to the scrap men I have talked to, one of the reasons for the shortage is that the scrap industry cannot possibly get this scrap at the existing fixed prices. Surveys made by the Department of Agriculture and by other official agencies in Washington apparently indicate, however, that there are several million tons of so-called "dormant" scrap in the country —agricultural scrap, automobile scrap, and miscellaneous other sorts of scrap, that evidently is not moving and apparently will not move under the existing price structure. If there are these several million tons of such scrap that could be obtained, even by the government subsidizing—to the extent of $5 or $10 per ton—its collection and movement, the whole iron and steel industry should be very much concerned with seeing that a strenuous effort is made by some agency to obtain it. Every additional ton of available scrap means just so much less blast furnace capacity, and ore, coke and other supplies, that has to be talked about for the immediate future, at any rate.

This concerns the iron ore industry, because there doesn't seem any possibility that more vessels to carry more ore and more furnaces to consume it, than have already been indicated can be provided before about 1944. It is just out of the question to provide within the immediate year or two ahead, all the additional facilities to produce pig iron for the steel plants and foundries necessary to make up for the shortage of scrap. If we are really in an emergency, every ton of scrap is almost invaluable to our defense program and warrants desperate efforts to collect it promptly and make it available for use.

F. W. JESSOP: Mr. McKee said the strip mills could roll a considerable tonnage of plate. Did he mean that would eliminate entirely the rolling of strip?

ARTHUR G. MCKEE: The strip capacity in this country is something like 18,000,000 tons per year. I talked about taking off 3,200,000 tons per year as plate, leaving around 15,000,000 tons of steel that can still go into strip, if everything is properly allocated.

C. G. BIGELOW: I would like to ask Mr. McKee, in all the interviews he has had in Washington, if he has found what is becoming of the 83,000,000 tons of steel we are making this year.

ARTHUR G. MCKEE: I spent a whole day trying to find someone who could tell me how much plate they would need in 1942. I finally obtained the figure of eight million and a half tons, and I do not know if that is correct within fifteen per cent, one way or the other.

We made a survey of the steel industry of Canada some months ago, and we got accurate, definite information as to the steel requirements of different sorts, properly scheduled, and divided, so that they knew how much steel they would need for next year. We

made a report on the subject. If the United States, on a much larger scale, of course, would do the same thing, then you could tell something about it.

E. E. THUM: I think the record will show that the capacity of this country has increased steadily, year by year, almost without interruption, for the last ten years, so that while most of the money spent recently, as Mr. McKee says, has been in rounding out capacity and putting in rolling mills, still in the actual figures for open hearth capacity you will find each succeeding year substantially larger than the one before.

Whether the rate of increase is large enough or not is not for me to say. It is sufficiently remarkable that the capacity has steadily increased during the troublesome 1930's.

I have made a considerable study of copper in the past two or three months, and I can check a great deal of what Mr. McKee says about the lack of adequate information. In Washington, however, the man at the head of the Copper Division of OPM is a practical man, John A. Church, who has spent a lifetime in the production of copper. Even so, the problem of getting detailed information from the industry concerning capacity, production, and expected uses is too big a job to handle with the staff down there. The copper industry, also, has never been in the habit of accumulating detailed statistics.

Unfortunately also, there is a lot of loose thinking on the part of the political members of the government. To illustrate, the official view in Washington stated on October 21st is that the civilian requirements of copper next year will be on the order of 1,100,000 tons. The normal consumption of America for copper in a boom year is about 800,000 tons, and that 800,000 tons includes all of the electrical equipment, and communications equipment, copper-containing materials for export and for the transportation industry—all items which are now classed not as civilian consumption but as defense requirements.

We expect to get about 1,650,000 tons of copper in 1942. A little over a million tons is earmarked for direct defense. Essential auxiliary defense purposes, which include much of the electrical industry, account for 250,000 tons more. This leaves about 350,000 tons of new copper for American civilians (according to OPM official figures) for 1942. If you take the 800,000 tons "normal" consumption, and deduct electrical, communications and transportation needs, you come out with a figure of around 250,000 tons, the amount OPM says we ought to have over for civilians in 1942.

Nevertheless, there is this figure floating around Washington of 1,100,000 tons necessary for civilian consumption for next year. The only way I can imagine that the amount was arrived at is that some economist decided that in 1938, when we used up some 800,000 tons of copper, our national income was a certain amount so he guessed that next year our national income would be 40 per cent greater than it was in 1938, so therefore we would use in 1941 40 per cent more copper than we ever did before. Such estimating was once used in figuring the steel "needs" of the American public. On that basis, of course, we haven't anywhere near enough copper to go around, but unquestionably the consumption of copper isn't nearly as large as one would imagine from that official figure.

A. M. MACCUTCHEON: I have been told by a pretty fair authority that one of the influencing factors in the plans for the future of the steel industry depends a great deal on the group of Senators and whether they think they need a new steel mill or new blast furnace in their state. That is entering very largely, I am told, into the determination of where new steel mills shall be placed and the amount of capacity.

Also this same source stated that he wasn't at all sure that we do not have all the capacity needed to produce steel that would be used this year effectively if they would avoid the matter of steel lying down in the shipyards now that is to be used for some boats, the keels of which will not be laid until June, 1943.

There is another interesting thing that causes shortage of capacity, and it is pertinent to Mr. McKee's idea of central planning. It happens with us right along that we will make strenuous efforts to get material for a certain schedule, say, 200 motors, and we will get in, in the case of a government order, steel castings, and then they will lie in our yard sometimes for two or three months while we are trying to get other materials necessary to complete production. There is a tie-up on steel capacity because the castings are just lying there idle. We could go ahead if we could get the other things, such as some special copper and so on, which is all authorized but because there is no central planning agency it doesn't come to match up with the steel castings we have already received. That is a little different angle along the line of the necessity for a central planning bureau.

EMERSON FINDLEY: May I ask Mr. McKee and Mr. Harbaugh if, in their judgment, the shortage in scrap would be alleviated or the shortage corrected if the ceiling on prices were removed so that there would be a temptation to bring out all this scrap that is in hiding?

ARTHUR G. MCKEE: Mr. Harbaugh said a while ago that in his opinion, or according to some advice he had, there were probably 10,000,000 tons of steel scrap which were not available to come in as purchased scrap at present prices. If we could get that in in the next two years, we would add five million tons a year to our possible steel capacity, because we have open hearth furnaces to make it into steel ingots.

Now, on the other hand, don't forget that when you gather in those ten million tons, at the end of two years you won't have ten million tons to fall back on. Then you will be back to less than the twenty-one million tons of purchased scrap that we are getting now, and that will probably be decreased after that, because there will be less resource of scrap behind the market. I think we should use every resource to bring in the scrap which is unavailable at present prices.

Suppose we got ten million tons at ten dollars a ton extra for that ten million tons, that would be $100,000,000. That is a lot less than the cost of blast furnaces to make that amount of pig iron to replace that scrap, and after the war is over we would be cumbered less with unnecessary equipment. It is a dollar question. It should be seriously considered.

M. D. HARBAUGH: I can only say what the scrap men I have talked to tell me about this. They very definitely feel that a substantial increase in price would bring out a considerable amount of that scrap. Just how much it would bring out, they can't say, of course. No one actually knows just how much dormant scrap there is.

I feel about this whole national emergency more or less as if our house were on fire. If we are in an emergency, if our house is on fire, so to speak, it is a very late time to start digging a well to get a water supply. We had better use all the available water supply we have and perhaps divert water from the garden for a while. If we must have steel to fight a war with now and in the next year and the year after that, then certainly we should exhaust every possibility of obtaining promptly this existing supply of vital raw material —this scrap that is lying about the country.

Men in the scrap business say that if scrap prices in various regions had been raised a few dollars about a year ago, when the prices were first established, the collectors in the junk business who gather up the sort of scrap we are talking about would not have left their businesses and gone to work elsewhere. They probably would still have had sufficient incentive to carry on their business. But they dropped it very largely because they could make more money in jobs, for there were plenty job opportunities open to them. Now, in order to revive this business by doing what might have been done less expensively a year ago, a substantially higher price would have to be allowed in order to provide any incentive for them to resume collection of scrap. However, some men well familiar with the scrap business feel that it is impossible thus to revive the normal scrap collection service that has been allowed to be destroyed.

Just how much the cost would be, I don't know, but I would say, that if it should cost $10 a ton extra to get this scrap, it is cheap, if we really need it now and next year and the year after that. Certainly it would be cheap in comparison to the alternative of trying to provide pig iron capacity in lieu of it, and cheap in comparison to the loss in vital production now, due to idle steel furnaces.

C. H. TATE: You are already using 40,000,000 tons of scrap, and if you endeavor to pay a $10 premium for 10,000,000 additional tons, it would be almost impossible to purchase the present 40,000,000 tons at the present market price. An increase of $10 on the entire 50,000,000 tons required would mean an investment of about $500,000,000. It then comes back to the question: Wouldn't it be better to let the scrap price float, seeking a level so that scrap would be purchaseable at a price comparable to pig iron, and in this manner an equitable blast furnace building program arrived at?

M. D. HARBAUGH: As a matter of fact, I think, that is a saner approach to the whole thing, and we will see some reasonable expansion plan developed more in line with the possibilities. I realize also that what you say about scrap is pertinent, to pay an excess of $10 a ton for part of it and not affect the cost of the rest is difficult. How that problem can be solved remains to be seen, but nevertheless, if we are in an emergency, if scrap exists, and if we must have scrap, then there must be some way to get it.

A. R. DAVIS: I would like to ask a question about the ten-dollar increase in the price of scrap. Wouldn't that just be "passing the buck?" In other words, your scrap would go up, and you are holding your other prices down. The company buying the scrap wouldn't be able to make any money, and naturally they wouldn't buy it. If you are going to hold your other prices down, I don't see how scrap prices can be raised.

M. D. HARBAUGH: My only thought on that is that there might be some arrangement made for the government to subsidize in part the collection and transportation expense. The government subsidizes everything else in this emergency when it finds it necessary to subsidize.

B. W. CORRADO: I have talked of the possibility of an increase in scrap price with a lot of scrap dealers and pig iron producers and steel mill men, and it seems as though most people don't think that they should make a blanket increase in price, but they do think there are certain types of scrap cleaning that could be subsidized. One of them is the junking of old cars, and the labor involved in junking old cars really doesn't make it a paying proposition.

One scrap dealer told me that in a trip through northern Pennsylvania and upstate New York he had seen about 100,000 old cars lying in the fields. That is roughly about 75,000 tons of scrap. That won't be junked. It just won't be made available unless the owners of those cars can either be subsidized in transporting them to a junk yard or else can have their labor paid for by the government. That is only one type of scrap.

Then there is another type of scrap, and that is scrap lying around on farms. The farmers, of course, are very short on labor, and a lot of farmers are hard put to operate their farms. They are making money, and they are just not interested in taking one or two pieces of old equipment to market. Of course, another point is that these little bits of scrap lying on these farms are at isolated points, and it is very hard for a dealer to take a truck and go marketing for one hundred miles or one hundred and fifty miles to get a few truck loads of scrap.

But there are certain types of scrap, such as scrap at plants, that could be obtained. General Motors turns out so many cars and gets a certain amount of scrap automatically. Most people that I have talked to don't feel that that should be subsidized scrap, but that a higher price should be paid for that. But as far as the information I can get is concerned, there doesn't seem to be much likelihood that the ceiling of scrap prices will be raised.

C. E. Hughes

PRESIDENT, ASSOCIATION OF IRON AND STEEL ENGINEERS

The President's Message

The problem of satisfying the requirements of armament programs, placed on top of a quickening civilian consumption, puts a burden on the iron and steel industry in which the best efforts may not be good enough. Many expansion plans have been announced; some are in progress. But while the majority of these expansions are still in project form, it is necessary for the steel plant operators and engineers to do a better job with what they already have. This method of increasing production carries the advantage that less time and money are required than for new construction. It is gratifying to note that this type of expansion has been quietly proceeding, and has already shown concrete results in the form of increased production.

It is also gratifying to know that the Association of Iron and Steel Engineers, through the medium of our technical meetings and standardization work, our publications and exposition, has been of material aid in this program. *The Iron and Steel Engineer* ranks foremost among journals devoted to the production of iron and steel. The yearly proceedings form a reference library of incalculable value. Our new modern publication, *The Modern Strip Mill,* is an important contribution to steel plant literature. The Iron and Steel Exposition has become a vital tradition in the industry. The latest developments in equipment used by the industry are displayed here, and their merits and uses explained and demonstrated by experts from the builders of the equipment.

Through these various activities, which are made possible entirely by the efforts of its members, the Association has rendered invaluable assistance to the iron and steel industry. Now, as never before, it is our duty to increase this assistance, and your President asks the full cooperation of each and every member to this end. Your President further pledges the Association to aid our country in the present emergency to the limit of our abilities.

NEWLY ELECTED OFFICERS *and* DIRECTORS

A. I. S. E.

1942

F. E. FLYNN

FIRST VICE PRESIDENT

C. L. McGRANAHAN

SECOND VICE PRESIDENT

A. J. FI

DIRECT

FRANK EDWARD FLYNN started in the steel business with the Superior Steel Company at Carnegie, progressing from the position of water boy to that of boss roller. In 1916, he started in charge of rolling at the Phillips Sheet and Tin Plate Company, which later became the Weirton Steel Company, and during his 11 years service there he became assistant manager and then manager. He went to the Trumbull Steel Company in 1928, as assistant vice president in charge of operations. This company later became a unit of Republic Steel Corporation, and he became district manager, with headquarters at Warren, Ohio.

C. L. McGRANAHAN'S first work in the steel industry was in 1916 with the American Sheet and Tin Plate Company. He worked in various positions with that company's different plants until 1931, allowing for one year World War service. In 1931 he joined the Inland Steel Company as superintendent of the company's Indiana Harbor hot strip mill, resigning in February 1936, to take his present position as assistant general superintendent with the Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania. Mr. McGranahan was graduated from Pennsylvania State College in 1916 with a bachelor of science degree in civil engineering.

LOUIS F. COFFIN began work with the Bethlehem Steel Company as mechanical engineer in 1916. In 1920 he was made general master mechanic, and in 1932 was advanced to his present position of superintendent of the mechanical department at Sparrows Point, Maryland. Mr. Coffin was graduated from Swarthmore College in 1909 with a degree of bachelor of science in mechanical engineering.

J. LEDLIE MILLER has been employed in the steel industry since 1909, serving as messenger, draftsman, and in the experimental engineering department of Carnegie Steel until he joined the army, where he served overseas as a lieutenant in the heavy field artillery. Serving as fuel engineer at the Bellaire works of Carnegie from March 1919 until that fall, he returned to the Carnegie Institute of Technology where he received his degree in mechanical engineering the following year.

Mr. Miller returned to Bellaire as fuel engineer and when this plant was closed, went to the Follansbee Brothers plant in Toronto, where he was annealing department foreman and assistant metallurgist until January 1, 1925. He served as fuel engineer of the Wheeling Steel Corporation in the Wheeling district from 1925 until he went to Youngstown for Carnegie in 1928. He acted as assistant chief engineer of Carnegie-Illinois Steel Corporation in the Youngstown district from 1928 to 1936. In 1937 he was appointed assistant chief combustion engineer of Republic Steel Corporation with headquarters in Cleveland.

FREEMAN H. DYKE graduated from Phillip Andover Academy and from the Massachusetts Institute of Technology. Mr. Dyke started in the steel business with the Wheeling Steel Corporation at their Portsmouth plant in 1920, and with the exception of three years with the Jones and Laughlin Steel Corporation he has been with Wheeling Steel Corporation continuously. After serving in several capacities in various departments, Mr. Dyke became superintendent of the blooming, bar and hot strip mills at the Steubenville plant.

H. R. MIDDLEBROOK, assistant division superintendent, power and fuel, for the Gary steel works of Carnegie-Illinois Steel Corporation, has been in the employ of this company for the past thirty years. Born in Manistique, Michigan, Mr. Middlebrook received his elementary and high school training in his home town. After attending the University of Michigan, he completed his electrical training at Bliss Electrical School in Washington, D. C.

Mr. Middlebrook began his steel mill career as helper in the power house, then switchboard operator, train motor foreman, power superintendent, assistant electrical engineer, and in February, 1939, he was appointed assistant division superintendent of maintenance, and subsequently entered the power and fuel department.

A. J. FISHER was graudated from the Colorado State preparatory school and later from the University of Colorado, college of engineering, with a degree of M.E. in mechanical engineering. Mr. Fisher began his steel mill employment with the Bethlehem Steel Company at the Maryland plant as assistant master mechanic of the sheet and tin mill division in 1924. After serving in several capacities in various departments, Mr. Fisher became fuel engineer in 1929, holding that position at the present time.

H. T. WATTS was born at Louisville, Kentucky, and attended the public schools in that city, receiving his bachelor's and master's degree in mechanical engineering at the University of Kentucky in Lexington. Mr. Watts was first employed at the Youngstown Sheet and Tube Company in Youngstown, Ohio, in the steam engineering department. He later became assistant steam engineer for that company.

Mr. Watts transferred to the Otis Steel Company in Cleveland, holding the position of steam engineer for that company. He joined the forces of the Surface Combustion Corporation, and was stationed at Pittsburgh in sales work and development. He was later appointed superintendent of power for the Gulf States Steel Company at Gadsden, Alabama, and later became combustion engineer for the same concern. This company was absorbed by the Republic Steel Corporation in 1937, and Mr. Watts holds the same connection with the Gulf States Steel Division of Republic.

L. F. COFFIN

TREASURER

J. L. MILLER

SECRETARY

FREEMAN H. DYKE

DIRECTOR AT LARGE

H. R. MIDDLEBROO

DIRECTOR

H. W. NEB

DIRECTOR

A. J. FISHER

DIRECTOR

H. T. WATTS

DIRECTOR

T. B. McELRAY

DIRECTOR

A. J. F. MacQUEEN

DIRECTOR

T. B. McELRAY was born in Youngstown, Ohio, and has resided there all his life. After graduating from public school, he was employed by the W. B. Pollock Company for about eight months, leaving to enter the employ of the Carnegie Steel Company under the supervision of B. R. Shover in 1900 as oiler. Mr. McElray was advanced to motor inspector, shop foreman, power house foreman and assistant superintendent, having charge of all electrical construction and operation of the Youngstown district. He was appointed superintendent of electric light and power, Youngstown district, in May, 1932, being responsible for the electrical installation of the 43 in. strip mill at McDonald, Ohio. It was at his suggestion that the assembling of control boards complete in groups at the factory was instigated.

Mr. McElray's education was acquired by home study and at the Y.M.C.A. night schools.

A. J. F. MacQUEEN was born in Thessalon, Ontario, Canada, in 1901. Mr. MacQueen attended public schools in Sault Ste. Marie, Ontario, and then worked for a period in the elctrical department of Algoma Steel Corporation, Ltd. He attended Toronto University and was graduated in 1925 with a B.A. Sc. in electrical engineering. The following two years were spent in General Electric Company's test course in Schenectady.

In 1927, Mr. MacQueen went with the Sharon Steel Corporation in the electrical department. He was made assistant chief electrician of the Sharon plant in 1930. In 1936 he transferred to the Rotary Electric Steel Company in Detroit as chief electrician, and in 1937 he was promoted to superintendent of maintenance in charge of the electrical and mechanical departments.

J. D. JONES, chief engineer of the Youngstown Sheet and Tube Company, Youngstown, Ohio, was born and raised in Pittsburgh and was educated at Pittsburgh Academy. From the outset he was interested in steel and set out to obtain a wide range of experience in the production of steel. He has worked in steel plants in Wheeling, Chicago, Buffalo, Pittsburgh and other cities.

In 1912, Mr. Jones went to Sault Ste. Marie as chief engineer of the Algoma Steel Company. In 1916 he went to the Gary works of the Illinois Steel Company as chief engineer until the latter part of 1919, when he returned to Algoma Steel Company as general superintendent, later becoming general manager and vice president. He went to Youngstown Sheet and Tube in August, 1935.

L. F. REINARTZ, a graduate of Carnegie Institute of Technology, entered the employ of the American Rolling Mill Company, Middletown, Ohio, in 1909 as a chemist. In 1912 he was appointed assistant superintendent of the Central Works open hearth department, and subsequently served as gas house foreman and assistant open hearth superintendent in the East Works. He was then made superintendent of both open hearth departments until 1923, when he was appointed assistant general superintendent of the Middletown Division. In 1930 he became works manager of Middletown Division and, in 1938, also assumed supervision of the Hamilton plant.

Mr. Reinartz holds a number of patents on open hearth products and equipment, and has written a number of articles for technical societies and press. His efforts have aided greatly in the development of the National Open Hearth Committee, of which he is chairman. He is a director of the American Institute of Mining and Metallurgical Engineers and is also quite active in various civic affairs.

A. W. DUNCAN, electrical superintendent of the Weirton Steel Company, Weirton, West Virginia, was employed by the Apollo Iron and Steel Company at Apollo, Pennsylvania, in 1898, following his discharge from the United States Army. He subsequently went with the Pressed Steel Car Company at Pittsburgh, successively holding the positions of wire chief, assistant foreman, and general foreman in the electrical department. In 1910 he became superintendent of the electrical department for the Phillips Sheet and Tin Plate Company, which later became a part of Weirton Steel Company.

H. W. NEBLETT, development and new design engineer, Inland Steel Company, Indiana Harbor, Indiana, has been particularly concerned with power plant work and the development of new steel mill equipment.

Mr. Neblett's steel mill experience began with the Mark Manufacturing Company at Indiana Harbor, Indiana, in 1916. Later the name was changed to the Steel and Tube Company of America, the plant now being owned by the Youngstown Sheet and Tube Company. He was located with this plant from 1916 to 1920, as assistant electrical engineer, and from 1920 to 1922 he was electrical engineer at the Chicago office of the Steel and Tube Company of America. From 1922 to 1928 he was with the Colorado Fuel and Iron Company as engineer in charge of electrification of steel plants including power plants, the electrification of the existing mills and new mills that were constructed during that period. From 1928 to 1932 he was head of the Neblett Engineering Company in Chicago, a consulting engineering corporation dealing with the design and installation of steel mill equipment. In 1932 he went with the Inland Steel Company, Indiana Harbor, Indiana, and assumed the duties which lead to the position he now holds.

H. W. NEBLETT

DIRECTOR

L. F. REINARTZ

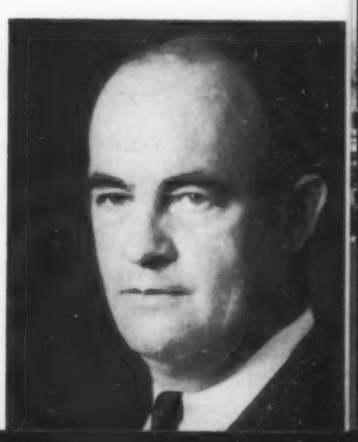
DIRECTOR

A. W. DUNCAN

DIRECTOR

J. D. JONES

DIRECTOR



National Committees for 1942

ASSOCIATION OF IRON AND STEEL ENGINEERS

General Chairman—T. E. HUGHES, President

ADVISORY COMMITTEE

Past Presidents, A. I. S. E.

1907–1908 JAMES FARRINGTON, *Electrical Superintendent*, Wheeling Steel Corporation, Steubenville, Ohio.

1909 JOHN C. REED, *Electrical Superintendent*, Bethlehem Steel Company, Steelton, Pennsylvania.

1910 F. P. TOWNSEND, *Engineer*, Copperweld Steel Company, Glassport, Pennsylvania.

1911 L. R. PALMER, *Conservation Engineer*, Safety Department, Equitable Life Assurance Society of U. S., New York, New York.

1914 E. FRIEDLANDER, Pittsburgh, Pennsylvania.

1917 F. D. EGAN, *Electrical Superintendent*, Bethlehem Steel Company, Lackawanna, New York.

1919 D. M. PETTY, *Superintendent Service Division*, Bethlehem Steel Company, Bethlehem, Pennsylvania.

1921 E. S. JEFFRIES, *General Manager*, Universal Boring Machine Company, Hudson, Massachusetts.

1922 W. S. HALL, *Chief Engineer*, Chicago District, Carnegie-Illinois Steel Corporation, Chicago, Illinois.

1923 R. B. GERHARDT, *Chief Engineer of Construction*, Bethlehem Steel Company, Bethlehem, Pennsylvania.

1924 R. S. SHOEMAKER, *Lubrication Engineer*, American Rolling Mill Company, Middletown, Ohio.

1925 A. C. CUMMINS, *General Superintendent*, Youngstown District, Carnegie-Illinois Steel Corporation, Youngstown, Ohio.

1926 *Chairman:* G. H. SCHAEFFER, *Electrical Engineer*, Carpenter Steel Company, Reading, Pennsylvania.

1927 S. S. WALES (Retired), Box B, Westside Station, Youngstown, Ohio.

1930 F. W. CRAMER, *Electrical Engineer*, Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania.

1931 F. O. SCHNURE, *Electrical Superintendent*, Bethlehem Steel Company, Sparrows Point, Maryland.

1932 J. J. BOOTH, *Assistant Superintendent of Maintenance*, Carnegie-Illinois Steel Corporation, Duquesne, Pennsylvania.

1933 J. D. DONOVAN, *Electrical and Mechanical Superintendent*, Republic Steel Corporation, Massillon, Ohio.

1935 W. H. BURR, *Electrical Superintendent*, Lukens Steel Company, Coatesville, Pennsylvania.

1936 G. R. CARROLL, *Assistant Superintendent of Maintenance*, Jones and Laughlin Steel Corporation, Aliquippa, Pennsylvania.

1937 H. G. R. BENNETT, *Engineer*, Hot Rolling Mills, Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania.

1938 L. F. COFFIN, *Superintendent*, Mechanical Department, Bethlehem Steel Company, Sparrows Point, Maryland.

1939 C. CLARKE WALES, *Vice-President*, Hamilton Bridge Company, Hamilton, Ontario, Canada.

1940 J. A. CLAUSS, *Chief Engineer*, Great Lakes Steel Corporation, Ecorse, Michigan.

1941 W. A. PERRY, *Superintendent*, Electrical and Power Departments, Inland Steel Company, Indiana Harbor, Indiana.

MEMBERSHIP COMMITTEE

Chairman: C. L. McGRANAHAN, *Assistant General Superintendent*, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania.

L. S. DAHL, *General Superintendent*, Carnegie-Illinois Steel Corporation, Dravosburg, Pennsylvania.

J. S. MURRAY, *Chief Electrical Engineer*, Follansbee Steel Corporation, Follansbee, West Virginia.

P. J. BOWRON, *Assistant Superintendent*, Annealing Department, Tennessee Coal, Iron and Railroad Company, Birmingham, Alabama.

A. L. LEMON, *District Manager*, Reliance Electric and Manufacturing Company, Birmingham, Alabama.

H. R. ZIMMERMAN, *Superintendent*, Electrical Maintenance Department, Carnegie-Illinois Steel Corporation, Gary, Indiana.

A. J. WHITCOMB, *Electrical Engineer*, Freyn Engineering Company, Chicago, Illinois.

ELMER J. WAGAR, *Assistant Chief Engineer*, Otis Steel Company, Cleveland, Ohio.

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E. F. WEISS, *District Manager*, Cutler-Hammer, Inc., Milwaukee, Wisconsin.

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Electrical Division — Welding Division
Combustion Division — Operating Practice Division
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A Foot in time May Save Nine!

Like everything else, wire is on that endless list of materials hard to get. And that means that any wire failure that makes rewiring necessary is a two-fisted punch on the nose!

Here's a sound suggestion. Go over your lighting, power and control circuits and pick out the spots where wire commonly fails—the hot spots; places where oil, grease, fumes and moisture make trouble; tunnels where wire is run near steam lines; around boilers, furnaces and other heat generators—then give us your minimum footage requirements and preference rating and we'll supply *permanently insulated* Rockbestos just as fast as we can.

A few feet of Rockbestos here and there may save repeated replacements because it is heatproof, fireproof and resistant to moisture, oil, grease, corrosive fumes and solvents. It won't fail under the toughest going, eliminates production tie-ups, saves time, trouble and money.

118 standard, permanently insulated Rockbestos wires, cables and cords to select from. Anticipate your requirements and send for a catalog.

Here's What We Mean by Permanent Insulation

A tough asbestos braid finished with compounds resistant to heat, flame, moisture, fumes, grease, oil and solvents.

A dense felted-asbestos wall impregnated with heat, flame and moisture resistant compounds.

Layers of lubricated varnished cambric for high dielectric strength and permanent moisture resistance.

Another felted-asbestos wall to completely seal the varnished cambric from the harmful heat of overloads.

A perfectly centered conductor.

Rockbestos A. V. C. (Underwriters' and N. E. Code Type AVA). Power and Motor Lead Cables have these insulation qualities.

ROCKBESTOS A.V.C.

The Wire with Permanent Insulation

ROCKBESTOS PRODUCTS CORPORATION, 829 NICOLL STREET, NEW HAVEN, CONN.

SYNCHRONOUS DRIVE FOR SHELL ROLLING

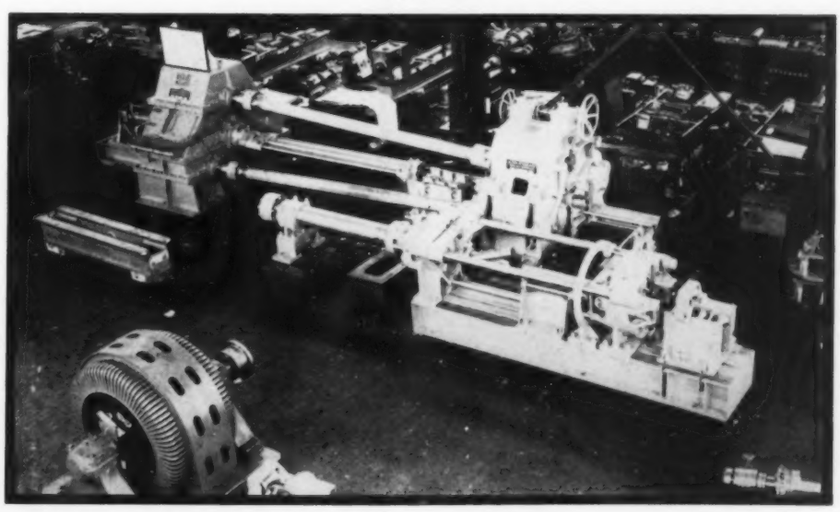
▲ Electric Machinery Manufacturing Company, Minneapolis, is building several 800 hp, 900 rpm, 0.8 power factor, coupled two-pedestal type synchronous motors to drive shell rolling mills currently being installed in many plants throughout the steel industry.

These motors are heavy-duty construction and are designed for 25 per cent overload for two hours with a temperature rise not to exceed 40 C. They will operate Assel cross-roll and elongator mills which were developed originally for processing mechanical tubing and have recently been adapted successfully to forging shells by the Witter process of the Salem Engineering Company.

The first mill of this type began producing shells at a plant in the Pittsburgh district early last January. Subsequently two additional mills using the Witter process were added there and a larger unit is being installed at the present time. More mills of the same type have been ordered for early delivery elsewhere in the industry. The first mills to be put into operation are producing shell forgings ranging from 75 mm to 7 in. in size.

The illustration shows an Assel mill, with its synchronous motor drive. A mandrel is put in the hole of the hot pierced blank forging and the piece revolved rapidly between two rolls similar to those used for making seamless tubing. After the forging has been elongated to the required rough shape for a shell, it is machined to final shape and size. A single Assel mill turns out several thousand such shell forgings in a 24 hr day.

This Assel mill rolls pierced shell blanks over a mandrel, using the same method as is employed in seamless tube production.



50TH ANNIVERSARY FOR BEARING FIRM

▲ With the year 1942, scheduled to be the busiest in its entire history, the Hyatt Bearings Division of General Motors Sales Corporation, Harrison, New Jersey, reaches its 50th anniversary.

Back in 1892 when John Wesley Hyatt, one of America's foremost inventors (father of the plastics industry through his previous invention of celluloid), established the Hyatt Roller Bearing Company, American industry was running chiefly on axle grease and plain bearings. His invention of the roller bearing and later developments by other anti-friction bearing builders ushered in a new machine age with all wheels and shafts of industry turning smoothly and economically on modern bearings today.

Likewise, are planes, tanks, guns and ships and other mechanized fighting equipment fully anti-friction bearing equipped.

Alfred P. Sloan, Jr. whose first job out of college was as a Hyatt draftsman, rose to its presidency and guided the firm through its major period of development. This coincided with the inception and growth of the automobile industry whose products more than any other have depended upon anti-friction bearings for speed and stamina. Under Sloan's leadership the Hyatt company was brought early into the General Motors group of which Sloan now serves as chairman of the board.

During its half century of sound growth from a one-man machine shop to its present vital position in American industry and armament, Hyatt contributed to many other major ad-

vances along with the motor car. In such industries as mining, railroading, agriculture, textile, aviation etc., the operating equipment too has been made more efficient through the design advantages brought about by these bearings.

Keeping apace with and often ahead of contemporary design, Hyatt bearings developed from a crude assembly of wound steel rollers that originally incorporated the principle of flexibility, in order to take up discrepancies of the 19th century wide tolerances, to a precision solid roller type of bearing that is held to microscopic tolerances of less than .0001 of an inch in quantity production.

The big Hyatt plant in New Jersey, a familiar landmark to Pennsylvania Railroad travelers approaching New York, is celebrating its Golden Anniversary this year by working three shifts day and night, under the direction of H. O. K. Meister, present general manager, building the millions of Hyatt roller bearings needed for the American Victory.

DEFENSE WORK STIMULATES TRUCK ACTIVITY

▲ As a result of the defense program, the demand for electric industrial trucks has become so acute that, during the past year, the industry has largely concentrated its efforts on stepping up production. Today, the Baker-Raulang Company is operating close to 2½ times normal capacity which is a real achievement, and the OPM has assigned a high blanket rating to assist in obtaining necessary critical materials.

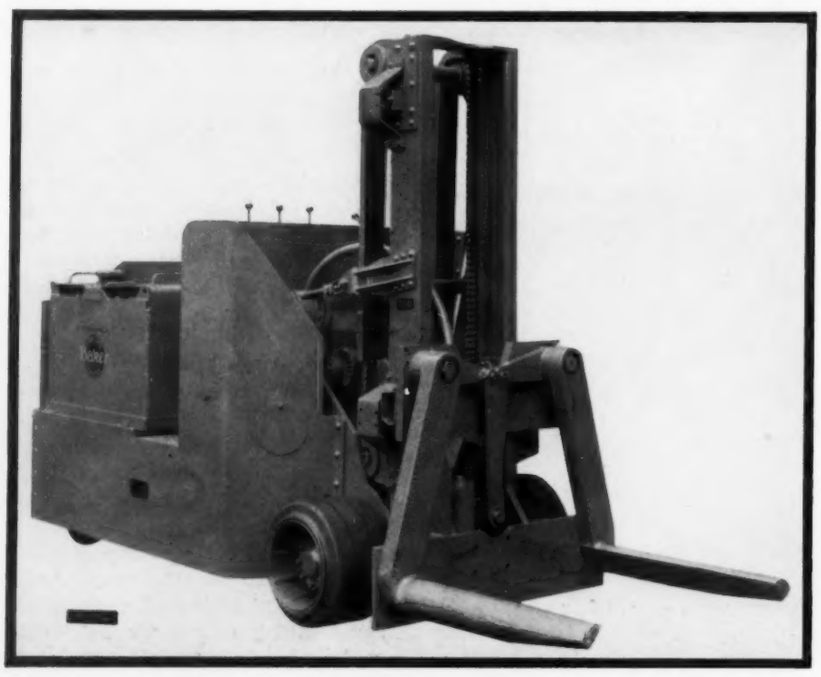
These trucks are going to companies which are increasing their production of defense materials, to steel mills, to the new ordnance plants, to army and navy air fields, ordnance depots, quartermaster depots, ammunition depots and navy yard supply bases.

While electric industrial trucks offer opportunities for both increasing production and reducing costs, the former is by far the most important under present conditions. New developments during the year have been limited almost entirely to special models for defense purposes such as the handling of bombs and projectiles.

During 1941 the Baker-Raulang Company has developed a device of interest to steel mills—a power driven ram shifter attachment. The company for whom this device was designed wanted a single ram at the center to handle one coil of strip steel or two rams spaced to handle two coils. Accordingly, Baker engineers designed a swinging type of split ram which presents a curved surface to the coil in either case.

The fork backs are built in bell crank shape and are swung outward or to the center by means of links connected to a nut which is operated by a screw. This screw is driven by a motor through a spur gear reduction. The motor is, of course, controlled from the driver's position and there are automatic limit switches for both limits of travel.

Ram trucks have been designed so as to handle either one or two coils at a time, as desired.



HEAVY DUTY HEATER FOR LARGE BUILDINGS

▲ Surface Combustion Corporation, Toledo, Ohio, announces the addition of a heavy duty unit heater to its line of Janitrol gas-fired space heating equipment. This new product is for the heating of large buildings such as airplane hangars, skating rinks, and factory buildings such as locomotive shops, steel mills, storage warehouses, arsenals and the like.

Heating of such buildings requires a unit heater which will deliver the air at high velocities, 1,500 to 2,500 ft per minute. Also, due to the low temperature of the incoming air, the heater must be able to raise the air temperature sufficiently to give a 100 to 125 F temperature rise.

This heater is built in sections, each section having a rating of 250,000 Btu per hr.

The new heater is known as the BBC-24 Janitrol series. The design incorporates the "Multi-Thermex" heat exchanger and "Amplifire" burner, both of which are features with Janitrol exclusively.

The unit is built up of a series of sections, each section having an input rating of 250,000 Btu per hour. Each section is complete, having its individual heat exchanger assembly, pilot, limit control and blower. The blowers of all the sections are mounted on a common shaft and driven by one motor. All sections are securely attached to a heavy channel iron base to insure ruggedness and alignment of the fan shaft.

A descriptive bulletin—"The BBC-24 Series Janitrol Unit Heater"—is available from the manufacturers.

LIGHTING UNIT FOR BLACKOUT SERVICE

▲ Following the requirments of the British air raid precaution specifications, Holophane Company, Inc., 342 Madison Avenue, New York, has produced a blackout lighting unit, the performance of which is within the severe limits established in England for this critical lighting application.

The specification states that the lighting fixture shall be of the suspension type consisting of a one-piece crystal glass refractor and fitter. Fitter shall be made of cast iron. Glass supported by clips, is held by screws for easy relamping. The junction between the hood and the prismatic glass bowl shall be gasketed to make the unit dust tight. Top of the fitter is to be tapped with a ¾ in. female pipe thread. Porcelain medium base socket with plated screw shell shall be securely fastened to the hood to prevent turning. Unit to be designed for use with a six watt, S-14, IF lamp. Over all depth of unit 7 in. Diameter of housing 10 3/16 in. Diameter of refractor over flange 5 7/16 in. The housing to be finished black inside and outside. The receptacle shall be so placed that optical relation exists between lamp and prismatic bowl and housing, so that the maximum candle power shall be not more than 2.0 at all angles below and including 90 degrees.

The usual spacing between units is 100 ft with a mounting height of 20 ft and under these conditions using a

Performance of the new unit is within the severe limits established in England for blackout applications.

TRADE AUTOMATIC MARK

MANUFACTURERS FOR OVER THIRTY YEARS

MODERN *Electric Propelled* INDUSTRIAL TRUCKS

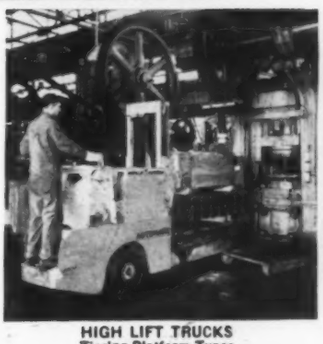
FOR ECONOMICAL MATERIALS HANDLING

- COIL AND FORK TRACTORS
- SHEET AND TIN PLATE HANDLERS
- BOSH TRUCKS
- LOW AND HIGH LIFT TRUCKS
- LOAD CARRIERS
- TRACTORS — CRANES

COIL TRACTORS
Capacities 8,000 to 18,000 lbs.

HEAVY DUTY COIL TRACTORS
Capacities up to 30,000 lbs.

FORK TRUCKS
Telescopic and Non-Telescopic Lifts
For Sheet Coils and Pallet Handling
Capacities 3,000 to 10,000 lbs.



REQUEST DETAILS AND LITERATURE

HIGH LIFT TRUCKS
Tiering Platform Types

TIN PLATE HANDLERS
Non-Telescopic and Telescopic Lifts

Listed Under Reexamination Service of
UNDERWRITERS' LABORATORIES

AUTOMATIC TRANSPORTATION CO.
47 W. 87th St. Div. of the Yale & Towne Mfg. Co. CHICAGO, ILL.

6 watt S-14 lamp the illumination will be approximately an average of 0.0002 foot candles and a maximum of 0.0004 foot candles (star light on a clear night). Obviously other mounting heights and spacing and other lamp sizes can be used to secure higher values of illumination as required.

It is important to note that the intensity of illumination on the ground secured by this unit—.0002—.0004 foot candles is the approximate equivalent of star light on a claer night. The absence of light at 90 degrees and above makes certain that there is not detection or identification of the units and consequently of the surrounding area from hostile planes. The illumination on the ground is symmetrical on the horizontal plane. This unit can be made to accommodate larger wattage lamps. In the present mechanical construction the range is from six watts to 25 watts. When a 10 watt lamp is used average .0004, maximum .0008 foot candles of illumination are secured. When a 15 watt lamp is used average .0008, maximum .0016 foot candles of illumination is secured. When a 25 watt lamp is used average .0014, maximum .0028 foot candles of illumination is secured. These intensities are based on 100 ft spacing and 20 ft mounting height.

Spindle Design *and* Construction Contribute *to* Close Accuracy *and* Fine Finish *of*

FARREL ROLL GRINDERS

Contributing substantially to the high precision and fine finish for which Farrel Heavy Duty Roll Grinders are noted are the construction and mounting of the grinding wheel spindle. Heavy, rigid and smooth-running, the wheel spindle is one of the outstanding design features of the machine.

For rigidity under working load the spindle is made as large as possible in diameter. It is made of high grade alloy steel, carefully machined, heat treated and ground to extremely close limits of accuracy. It is mounted in special bronze alloy, or steel-backed, babbit-lined bearings of the sleeve type, split longitudinally to fit a wedge by means of which the running clearance is closely controlled.

Thrust on the spindle is taken by a hardened steel disc and two babbitted rings at the center of the spindle, which permits free expansion of the spindle bearings and minimizes deflection of the spindle under thrust load.

Vibrationless, multiple V-belt drive, continuous automatic lubrication and other Farrel features combine to assure the smooth-running spindle needed to deliver continuously close accuracy and fine finish of ground rolls.

For full particulars of the Farrel Heavy Duty Roll Grinder send for a copy of Bulletin No. 111

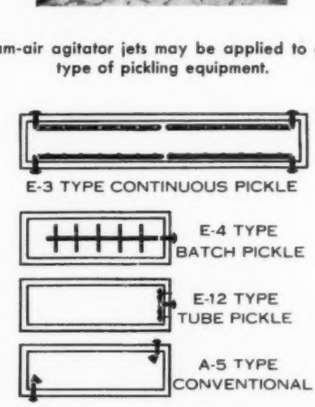
FARREL FARREL-BIRMINGHAM COMPANY, Inc.
ANSONIA, CONN.
New York • Buffalo • Pittsburgh • Akron • Chicago • Los Angeles

STEAM-AIR AGITATORS FOR PICKLING TANKS

▲ The desire to increase production of steel for defense with the available facilities in the pickling room has placed particular emphasis on the new E-series of Heil steam-air agitator jets used in pickling tanks. Already installed by the Heil Company, of Cleveland, Ohio, in over 75 per cent of continuous sheet mills, these jets increase the tonnage speed through the pickling line from twenty to forty per cent.

A similar set-up called the E-4 type is available for batch picklers. These

Steam-air agitator jets may be applied to every type of pickling equipment.



produce agitation and heating up through the bottom of the pack reducing the black patch rejects; at the same time eliminating the necessity of many hairpin spacers, sand, and other subterfuges for separating the sheets or coils.

The E-12 type steam-air agitators are designed for use in tube picklers, permitting either steam or air to be blown through the tubes. This rapidly removes the ganister, producing more effective pickling internally in a shorter period, with the consequent reduction of the usual overpickling of the outer surface.

The advantages obtained with these new agitator jets are derived from strategic placement of jet nozzles allowing for complete agitation of the entire bath. The angle of jet impingement is so arranged that a swirling or rolling action of the bath results. These results have long been desired, particularly in large continuous tanks where the use of conventional corner jets has been the vogue. An immediate deduction can also be made that more uniform heating results from the multiple nozzles and the complete agitation.

The above mentioned results are made possible by the patented construction involved in the recent developments. The jet stems are made of a ductile lead alloy, extruded into a special reenforced shape. The jet can be made in any length or shape. The nozzles are made of non-metallic Nocorodal which is unattacked in boiling acid pickle. The entire construction will withstand corrosive attack of the highest sulphuric acid concentrations developed in modern pickling practice at 220 F with no appreciable loss of weight.

During periods when steam is throttled by automatic controls, it is advocated that air be used in the same jet to provide continuous bath agitation. The air can also be entrained with the steam. To provide the same agitating effects, a much lower air pressure is required than with steam.

OLD PLANT CONVERTED TO PRODUCE ARMAMENT

▲ The old Savannah Avenue plant (21,000 sq ft) in Canton, Ohio—long in disuse—has been revitalized by the Timken Roller Bearing Company for the exclusive purpose of manufacturing the 37 mm shot.

There are two shells that will go a long way to win this war, and thus will be made in almost limitless quantities. These are the 20 mm and 37 mm shells. The Timken company, in spite of its overtaxed facilities in the production of tapered roller bearings for national defense, is now making the 37 mm shot and will undoubtedly, in the near future, start production on the 20 mm.

The 37 mm is a one-piece armor piercing shot. S. A. E. 4150 modified steel bar stock is used. The steel is produced in the company's own mill. It is heated, preparatory to hardening, in an atmospheric controlled furnace, quenched in oil and air tempered. The 1 9/16 in. bar stock is machined on multiple spindle, 2 5/8 in. automatics, having a finished weight of 1.91 lb. Exact inspection is required to come within weight tolerances specified. Banding is done by a cold swaging method, and then turned to size. The shot is painted externally with the exception of the rotating band. Machinery is being set up to produce 15,000 of the 37 mm shot per day.

BETTER RESULTS IN FURNACE OPERATION with HAYS INSTRUMENTS

SUPERSENSITIVE DRAFT RECORDERS SERIES "OT" You can make sure of BALANCED Draft Conditions in Open Hearths, Soaking Pits, Annealing Furnaces and Slag Mills by installing Hays Series OT Recorders.

These instruments give a correct indication of furnace atmospheres and a permanent record of pressures and drafts at vital points as guides for most effective operation.

Write for descriptive bulletin.

PATENTS PENDING. This gage is calibrated in terms of air and gas flow—but may be used for any two flows for which the instrument is calibrated.

HAYS VISIO-RATIO GAGE

3 INSTRUMENTS IN 1 . . . 1. Air-Flow Indicator . . . 2. Fuel-Flow Indicator . . . 3. Ratio Indicator. Shows at a glance the exact ratio existing between flow of gas or flow of oil or other measurable fluid: pressure, draft, suction, temperature (up to 1000° F.) speed in R.P.M. or inches per minute, position, level and others.

This newest Hays instrument is a guide to higher manufacturing efficiency, increased production, better products and lower costs. It shows relations at a glance and eliminates the necessity of making calculations to determine excess or deficiency.

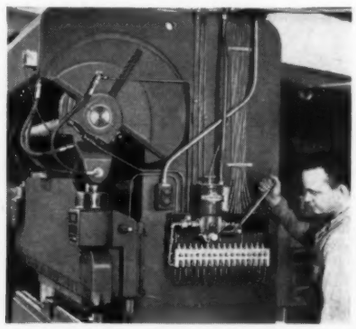
If you will write us, stating the conditions, we will tell you exactly how the Hays Visio-Ratio Gage can be applied to your problem.

The HAYS CORPORATION
SINCE 1907 COMBUSTION INSTRUMENTS AND CONTROL
MICHIGAN CITY, INDIANA, U.S.A.

LUBRICATION SYSTEM OFFERS NEW FEATURES

▲ Lincoln Engineering Company of St. Louis, Missouri, pioneer manufacturers of engineered lubricating equipment for all purposes, have incorporated many new features in their latest centralized lubricating system. The Lincoln Centro-Matic system, now in wide use on industrial machinery of all kinds, is an easily installed system for lubricating all bearings. The system consists of a number of injectors—one for each bearing to be lubricated, each connected to the bearing by tubing or flexible high-pressure hose as required, and each individually adjusted to discharge the required amount of lubricant. The injectors can be mounted singly or in manifold and are supplied with lubricant from a central pumping unit.

An outstanding feature of the Lincoln system is the single lubricant supply line between the pumping unit and the injectors. Another feature of the system is the wide range of pumping units now available, and the varied types of control. The pumping unit on the Centro-Matic installation illustrated, is the new 2 lb pump. It can be easily mounted right on the machine, and a few strokes of the handle delivers lubricant to all bearings. Other pumping units with 30 lb capacity, as well as pumps that handle lubricants direct from 100 lb and 400 lb capacity original drums are also available, and the entire systems can be either electrically operated with push button control, or entirely automatic with time clock control.

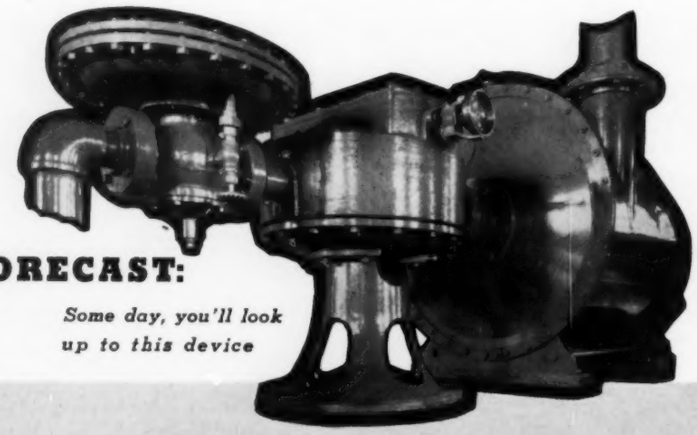


Injectors may be mounted in manifold and served by a central pumping unit

The manufacturer advises that an engineering staff, trained in industrial lubricating problems is available for consultation. Literature is also available and can be had by writing to the industrial lubricating department, Lincoln Engineering Company, 5701 Natural Bridge Avenue, St. Louis, Missouri.

IMPROVED DESIGN IN DIESEL-ELECTRIC

▲ Completion of a new 50-ton diesel electric locomotive for general switching use has just been announced by the H. K. Porter Company, Inc., 5018 Harrison Street, Pittsburgh, Pennsylvania. Powered with two Cummins diesel engines, each developing 150 hp, the locomotive has a



FORECAST:

Some day, you'll look up to this device

BASIC

in modern mill practice

This is the patented, exclusive Kemp Industrial Carburetor, the machine that provides *complete* premixing of gas and air to provide new savings, new heat liberation, new flexibility and new control in almost every type of ferrous and non ferrous heat processing.

As the basic unit in Kemp heat treating the Industrial Carburetor supports gas immersion melting in modern tin stacks, provides fuel for inert gas and for recirculating radiators in annealing covers, for Kemp Radiatube Roll Heaters, may be set for exactly the desired flame characteristics whether reducing, oxidizing or for complete combustion . . . and save 15 to 40 percent in fuel. For engineering details and assistance, address **The C. M. Kemp Manufacturing Company, 405 East Oliver Street, Baltimore, Maryland**

KEMP of BALTIMORE

tractive force of 30,000 lb at 30 per cent adhesion. Overall size is 12 ft high by 9 ft, 8 in. wide by 29 ft, 8 in. long over bumpers.

The new locomotive differs from the standard line of Porter diesel electrics in the method of driving the second axle of each truck. Instead of the standard forged steel side rods, each truck is driven by a heavy duty chain enclosed in oil. Thus in this design, intended for use where extreme clearances and sharp curves are encountered, the overhang of side rods is eliminated.

This diesel-electric switching unit offers high power and rugged construction.

For extreme strength, main frames are constructed of heavy steel plates, welded together with slab steel bumpers, and strongly braced lengthwise and crosswise. Radiators, engines and generators are mounted on heavy steel bedplate designed so that the entire unit, with bedplate, can be removed easily.

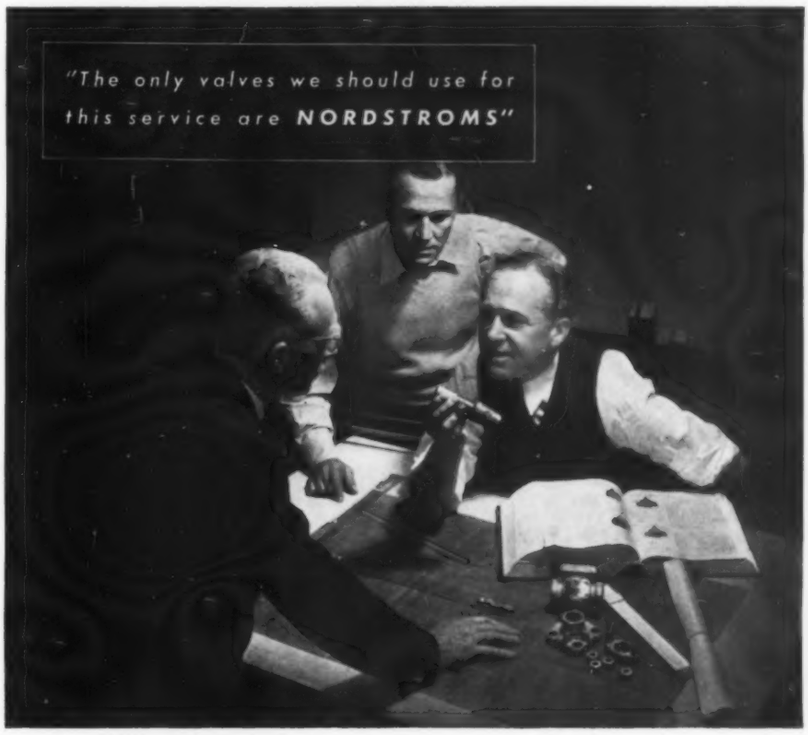
The manufacturer will be pleased to supply additional details upon request.

CONTACTS ATTACHED BY ELECTRIC BRAZING

▲ The growing demand for silver alloy contact materials in the construction of electrical equipment has necessitated the development of new techniques for attaching these alloys to base metal parts of switch structures. The electric brazing process is proving of value in this connection.

An interesting illustration of the attachment of contact materials to heavy copper castings may be noted in the accompanying photograph of 4,000 ampere disconnect switch jaw and hinge to which strips and rings of silver-nickel contact material (Gibsiloy Grade A) were brazed by the Gibson Electric Company of Pittsburgh. Eight strips $\frac{1}{4}$ in. x $\frac{1}{2}$ in. x $3\frac{1}{2}$ in. were brazed to the jaw and four rings $\frac{1}{4}$ in. thick, 3 in. outside diameter, $2\frac{1}{8}$ in. inside diameter were brazed to the hinge. Each casting weighed 35 lb. All of the contacts on each casting had to be brazed at one time; otherwise the bonds of the contacts first brazed might be damaged by the heat required to braze the other contacts.

To accomplish this, the contacts were placed on the casting and the casting held between graphite electrodes of a 50 kva welding machine, the outer contacts being held by these electrodes. The inner contacts were also held between graphite blocks which were pressed against the contact material by means of the wedging clamp illustrated. Very little of the current passed through this inner clamping device because it was



NO CORROSION—NO EROSION

In this day of national defense, Engineering Departments in steel plants are giving more heed than ever before to valve needs. In many services only Nordstrom Lubricated Plug Valves will perform to the full satisfaction of engineers. The longer life of Nordstroms, their freedom from sticking, and their resistance to corrosion and erosion, present economy advantages as well as assurance of safety. Especially desirable on gas lines. Ask for Bulletins.

KEEP UPKEEP DOWN WITH

NORDSTROM LUBRICATED VALVES

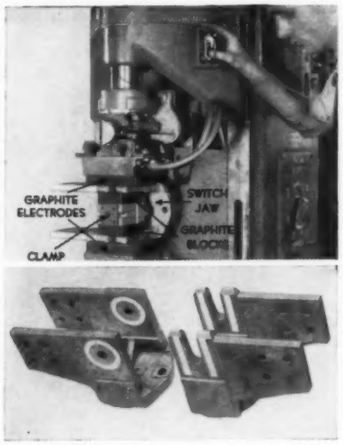
MERCO NORDSTROM VALVE CO.

400 LEXINGTON AVENUE PITTSBURGH, PENNA.

bi-passed by the base of the copper casting itself. Most of the heat was therefore generated in the outer electrodes and the casting had to be brought up to heat slowly in order to give time for as nearly an even distribution of heat as possible, so that the inner contacts could be brazed before the outer contacts tended to melt.

The brazing medium was silver solder which had been applied as a solder flushing on the sheets of silver-nickel from which the contacts were made.

The copper blades of the switches on which the illustrated jaws and hinges were used, were also equipped with silver-nickel contacts. To each blade were brazed 2 strips of silver-nickel contact material (Gibsiloy Grade A) $\frac{1}{64}$ in. x ½ in. x 3½ in. and one ring $\frac{1}{64}$ in. thick, 3 in. outside diameter, 2⅛ in. inside diameter. In this case, one end at a time could be heated, so the two strips were brazed to one end of the blade at one time and the ring brazed to the other end as a separate operation.



View showing switch parts and method of attaching silver contacts.

While the case here illustrated involves the application of contact material to large switch parts, the electric brazing method is equally applicable for attaching contacts to smaller parts such as contact fingers, springs, screws, studs, stampings, and extruded sections.

TOOL HOLDER OFFERS SAFETY FEATURES

▲ A completely new device which is made to hold square or octagon shaped tools such as steel hand stamps, chisels, and other similar hand tools has been announced by the M. E. Cunningham Company, 105 East Carson Street, Pittsburgh, Pennsylvania. This new safety adjustable hand tool holder is made so as to be adaptable for holding any size piece from ¼ in. to ¾ in. and other ½ in. ranges up to 1¼ in. square. This holder provides a means for holding the different hand tools to eliminate possibility of split or smashed fingers usually caused by foul hammer blows. Also, because the stamp (or other tool) is held securely in the holder there is no chance of it flying and casing injury to nearby

Even in Winter
Hot Spots Slow Up
Production . .

TRUFLO CRANE CAB FANS
For cooling interiors of crane cabs and other confined areas. Adjustable both horizontally and vertically. Four blade type, 12 and 18 inch sizes.

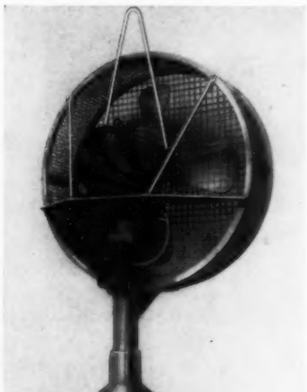
Keep Workmen Cool
with
TRUFLO FANS

During even the coldest weather there are "hot spots" in many mills—places where heat and foul air play hob with production.

Truflo Fans can keep your men on their toes all year around. All Truflo Fans are designed and built to put fresh, cool air exactly where it is needed. Perfectly balanced blades give more air per h.p. . . . strong steel frames stand up longer under hard use . . . rugged wire guards protect men against injuries.

There is a type of Truflo Fan for every cooling and ventilating use. Write for literature on any of the following kinds:

PORTABLE COOLING FANS
CRANE CAB FANS • WALL FANS
EXHAUST FANS • BLOWERS
ROOF VENTILATING FANS
PENT HOUSE FANS



TRUFLO PORTABLE COOLING FANS
Easily portable. Help keep efficiency high where work is hottest. 12 to 36 inch diameters.

TRUFLO FAN COMPANY
554 MAIN ST., HARMONY, PA.

workers. It is possible to get a clearer and more even impression with stamps held in this holder because they can be held squarely in place, and where necessary, can be hit harder so as to drive in deeper.

Holder can be furnished with a leveler on front end which protrudes at the proper angle to allow the operator to make several impressions in a straight line.

Holder is made from steel tubing which is slotted through in a 'V' shape to provide for holding tool. A special coil spring fits inside of the tubing and is held in place by a back plate on one end of the tubing. A smaller piece of tubing is placed at the other end of the coil spring and a special vulcanized rubber plug is placed into the tubing. The spring provides the tension against the tool while the rubber provides the friction to prevent tool from flying out of holder.

The adjustable hand tool holder is built to give long service and is balanced and strengthened in the necessary spots to eliminate any unusual wear. These tools are priced at $6.00 each for size to hold pieces ¼ in. to ¾ in., in lots of one to eleven; for lots of twelve or more price is $5.00 each.

CO_2 RECORDER IMPROVED

▲ Recent improvements in Micromax CO_2 recording equipment are described in a revised catalog issued by Leeds and Northrup Company. Heavy-walled glass tubing in shock-absorber mountings now brings the continuously flowing flue-gas sample from primary filter to cell assembly. Three-way cock for check purposes and condensate drain, previously of metal and external to the cabinet, are now of glass and housed in a separate compartment. Because the flue-gas sample comes in contact only with glass from the time it leaves the stack until it is automatically analyzed, maintenance due to corrosion is eliminated. In addition to a complete description of the equipment, the revised catalog contains full-size reproductions (in color) of round and strip-chart records and illustrations of installations. To receive a copy, ask

Electric Lacquer Prolongs Motor Life!

Expensive motor repair jobs may often be avoided and the life of electrical equipment prolonged by renewing the original insulation with an application of DOLPH'S ELECTRIC LACQUER at regular intervals.

This re-insulation may be accomplished easily and quickly without interfering with all-out production as the shut-down of electrical equipment for any length of time is not required.

Briefly, here are some features offered by ELECTRIC LACQUER:

1. Faster air drying.
2. Application by brushing or spraying.
3. Oilproofness.
4. Maximum resistance to acids and moisture.
5. Complete sealing of cracks and defects.
6. Dielectric strength of over 950 volts per mil.

Take the first step toward the reduction of motor maintenance costs in your mill by writing today for information on "DOLPH'S Preventive Maintenance Plan."

Dolph's

JOHN C. DOLPH COMPANY

Insulating Varnish Specialists

166A EMMETT ST. NEWARK, N. J.

Leeds and Northrup Company, 4934 Stenton Avenue, Philadelphia, Pennsylvania, for Catalog N-91-163, "Micromax CO_2 Recording Equipment for Flue-Gas Analysis".

CERAMIC INSERTS FOR AIR BLAST NOZZLES

▲ An extremely hard, abrasion-resisting ceramic is now being used instead of metal for the inserts of "Long-Lyfe" nozzles manufactured by American Foundry Equipment Company, 555 South Byrkit Street, Mishawaka, Indiana. The product is the result of years of research in the field of colloidal chemistry.

The ceramic insert is claimed to have a hardness and density that is superior to many of the metals now being used for this purpose. Its manufacture is not affected by the present scarcity of certain metal alloys.

The new nozzle is unusually low priced. The savings in first costs alone amount to as much as 25 to 40 per cent.

Further savings are effected during operation: The cost of compressed air is kept at an absolute minimum because the nozzle wears slowly and evenly. Since the original orifice is preserved without appreciable wear, even after hundreds of hours of service, the contour of the blast stream is maintained and the work is cleaned faster and more uniformly.

The jacket enclosing the insert is improved, too. It is made of the same type of abrasion-resisting alloy steel used in the blades of the American airless Wheelabrator. Additional features of this nozzle include: (1) High finish bore; no soft spots to start uneven wear. (2) Non-metallic, thus reducing static to a minimum. (3) Does not "bell out" rapidly. (4) Excellent mechanical strength. (5) Adaptable to any equipment.

Two types of nozzles are available: The flange type and the screw type. Adapters can be supplied for fitting the nozzle to any type of air blasting equipment.

DATA BOOK AVAILABLE

▲ A complete handbook on Meehanite castings, describing their manufacture, metallurgy, and engineering properties has just been published by the Meehanite Research Institute of America, Inc., 311 Ross Street, Pittsburgh, Pennsylvania. The book contains forty-seven pages of facts important to engineers, designers, machinery manufacturers, and every user of castings.

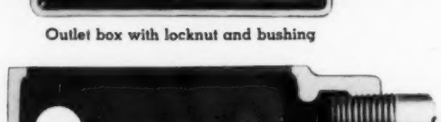
CONDULETS
MANUFACTURED ONLY BY
CROUSE-HINDS

Three of the outstanding reasons why **Condulets** do a better job are—

1 **FERALOY METAL**—Strong and Lasting
2 **TAPER TAPPING**—A Secure Joint
3 **FINISH**—Three Separate Protective Coats

2 TAPER TAPPING-

Outlet box with locknut and bushing



Crouse-Hinds **Condulet** with taper tapped thread

Taper Tapping is better

- Provides the most permanent and rigid joint, not affected by vibration.
- Requires no auxiliary support, because of the strength of the joint.
- All hubs tapped simultaneously, assuring proper alignment.
- Assures permanent ground continuity.
- Provides protection at joint, thereby eliminating corrosion.
- Uses fewest number of parts, therefore is the cheapest and best.

A Nationwide Distribution Through Electrical Wholesalers

CONDULETS—The Standard of Quality in the field of electrical conduit fittings.

CROUSE-HINDS COMPANY
SYRACUSE, N. Y., U. S. A.

Sales Offices: Birmingham Boston Chicago Cincinnati Cleveland Dallas Detroit Houston Kansas City Los Angeles Milwaukee Minneapolis New York Philadelphia Pittsburgh San Francisco Seattle St. Louis Washington
Resident Salesmen: Albany Atlanta Baltimore Buffalo Charlotte Denver Louisville New Orleans
CROUSE-HINDS COMPANY OF CANADA, LTD., Main Office and Plant: TORONTO, ONT.

NEW PUMP LINE FOR SPECIAL PURPOSES

▲ A new series of corrosion-resisting pumps in which it is possible to get 480 combinations of alloys, types and sizes with heads and capacities to meet practically any requirements was displayed at the recent Exposition of Chemical Industries by The Duriron Company, Inc. of Dayton, Ohio.

They have a convertible feature said to be obtainable only in these pumps. "Durcopumps" that are made in the high-silicon irons, Duriron and Durichlor, can be converted to stainless steel pumps simply by substituting only the wet-end parts. The exchange can be made without disturbing the setting of the pump.

This convertible feature is said to be especially valuable where there is apt to be changes in the liquids handled. For instance, a Durcopump of Duriron for unloading acid tank cars can be converted to stainless steel to pump caustics. This is an additional advantage during the present emergency when delivery on new equipment is apt to be delayed.

Other features include the interchangeability of newly designed open and closed impellers with negative pressure on the stuffing box; oversize ball bearings throughout, and micro-adjustment of the impeller to obtain maximum efficiency.

Bulletin No. 810 illustrates and describes these pumps in detail, with complete dimensions for all sizes. You are invited to write for a copy, mentioning this publication.

OTIS STEEL BREAKS PRODUCTION RECORDS

▲ Four all-time production records were broken by The Otis Steel Company during 1941, according to E. J. Kulas, President.

Operating at nearly 19 per cent in excess of its rated capacity for the year, Otis produced 1,028,266 tons of steel ingots. Its rated capacity is 927,000 tons.

The company's 77-inch continuous hot mill, one of the first to be installed in the United States, broke all previous records by 93,941 tons. Pig iron production was also the greatest in history, exceeding the previous high by 5.9 per cent.

A 1929 record of 80,000 tons of steel plate at its Lakeside plate mill was exceeded during 1941 by 24,000 tons. The Lakeside mill is one of the first plate mills to be installed in the country and the product is vitally needed for the construction of ships, railroad cars and other defense necessities.

"Otis Steel," said Mr. Kulas, "is engaged in an 'all-out' effort to supply steel so urgently needed in our warfare against the Axis nations. Though 1941 was a record year, I am convinced that the Otis organization will show equally amazing new records at the end of 1942."

ANNOUNCES NETWORK DISTRIBUTION UNIT

▲ Especially designed for industrial plants using secondary network systems, a new air-cooled network distribution unit is announced by Westinghouse Electric and Manufacturing Company.

Consisting of a high-voltage double-throw primary transfer switch, an air-cooled 3-phase transformer and network protector housed as a single unit, the assembly transforms power from the primary voltage to secondary grid voltage. Ratings are from 300 to 1000 kva on all standard voltages between 2300 and 13,800 with secondary voltages of 125/216 four wire, 226/460 four wire and 460 three wire.

Primary air-break switch opens the exciting current of the associated transformer and will withstand a short-circuit current of 10,000 amperes for two seconds without damage to or appreciable movement of its parts.

The three phase transformer is of the dry type, air-cooled and insulated with non-inflammable materials. It is designed to carry rated kva at normal voltage and frequency without exceeding 75 C rise above an ambient temperature of 40 C. High voltage windings are delta-connected with four 2½ per cent full capacity taps below normal; low voltage windings may be star or delta connected with no taps.

Network protector is the three-pole open type securely mounted in the low-voltage end of the unit housing and adequately spaced and barriered from all high voltage circuits of the unit to permit inspection, test, and maintenance without danger of contacting high voltage portions.

BULLETIN DESCRIBES ELECTRIC MOTORS

▲ The Wagner Electric Corporation recently published a new 34-page bulletin on single-phase, direct-current, and small polyphase motors manufactured by the company.

The bulletin contains detailed descriptions of the construction of repulsion-start-induction motors, repulsion-induction motors, capacitor-start motors, split-phase motors, direct-current motors, small polyphase motors, fan motors, and explosion-proof motors.

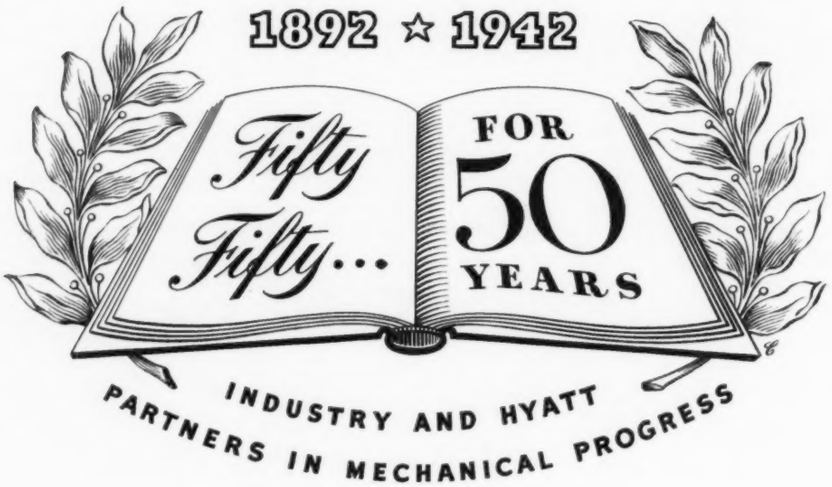
This new bulletin is now available for distribution to those interested in the above listed motors. For a copy, address Wagner Electric Corporation, 6483 Plymouth Avenue, St. Louis, Missouri, and ask for "Bulletin MU-183".

BLACK-OUT COATING FOR INDUSTRIAL USE

▲ Carbozite Corporation of Pittsburgh announces a new black-out coating for industrial plant windows and skylights that meets all of the authoritative specifications and recommended practices and features easy removal when danger no longer exists. Known as Carbozite standard black-out black, this coating is not a paint but a smooth flowing liquid coating, manufactured from a pyrobitumen ore, especially refined and mixed with quick drying, volatile solvents and a secret ingredient which provides complete opacity and an absolutely gloss-free surface. No preference rating or priority is needed to obtain black-out black as its main ingredients consist of non-essential hydro-carbons which are not in demand for munitions or other war materials. Of particular interest is its ease of application and outstanding durability under even the most actively corrosive conditions . . . which permits its use anywhere.

It is understood that the greater part of the Carbozite Corporation's facilities are being devoted to the production of black-out black to meet the impending needs of many industries. Additional information about black-out black is obtainable from this publication or from the Carbozite Corporation, First National Bank Building, Pittsburgh, Pa.

THANKS, INDUSTRY!



WE'VE COME A LONG WAY TOGETHER during the past fifty years. We've helped America through emergencies . . . and through the greatest industrial era in her history. We've brought the advantages of anti-friction roller bearings to the many new and perplexing mechanisms of industrial pioneers. The accomplishments have been great, the rewards rich . . . for Industry, for Hyatt, for America!

Inventive genius and engineering talent have guided us through the years . . . the experiences of one have helped and improved the other. Many design problems have been solved. Many application handicaps have been overcome. We've shown each other many new, better ways of doing things.

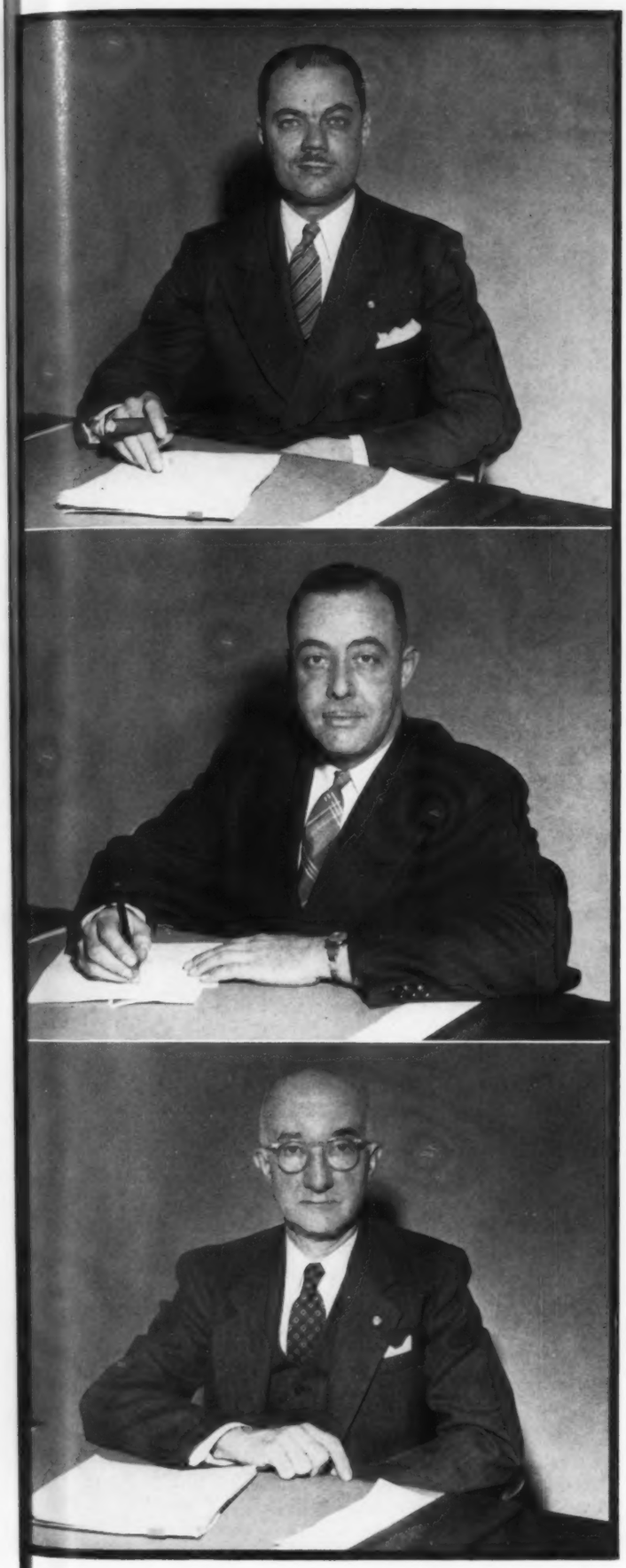
Today, on our 50th Anniversary, we feel gratified that you are placing Hyatts in machinery and equipment of all kinds...in factory and field, on highway and railway, in war and peace-time assignments . . . that you are calling upon Hyatt and Hyatt Roller Bearings, more than ever before, to help in upholding the excellence of your regular products and the products you are building for Victory.

For this confidence, again we say . . . THANKS, INDUSTRY. Hyatt aims to keep pace with you into the future—America's future—building the very best that seasoned experience and fresh imagination can produce. So let's set our sights on tomorrow . . . let's keep going "Fifty-fifty for 50 years" . . . and more!

Hyatt Bearings Division, General Motors Corporation, Harrison, N. J., Chicago, Pittsburgh, Detroit and San Francisco.

HYATT

QUIET ROLLER BEARINGS



ITEMS OF INTEREST

Oscar B. Winey, industrial sales manager for Socony-Vacuum Oil Company, Inc. in the Pittsburgh district has retired, having completed 40 years of service. He originally entered the employ of the Standard Oil Company interests as stenographer-clerk in 1901. When the old Standard Oil Company was dissolved as of December 31, 1911, he was transferred to Philadelphia, where he served four years, after which he returned to Pittsburgh with the Vacuum Oil Company.

At left (top to bottom) Homer A. Smith, E. S. Reynolds and Oscar B. Winey

All of his service has been in Pittsburgh with the exception of the four years referred to in Philadelphia.

Homer A. Smith has been appointed industrial sales manager, Pittsburgh district, for Socony-Vacuum Oil Company, Inc., covering sales, engineering, etc. Mr. Smith was Engine Builders Division representative since 1930. He will be succeeded in this work, which is a technical lubrication service and development, by **E. S. Reynolds.** Both Mr. Smith and Mr. Reynolds are graduates of Syracuse University in mechanical engineering, and are members of the A. I. S. E.

R. E. Bingman has been appointed district manager in the Indiana territory by Jessop Steel Company, Washington, Pennsylvania, with headquarters at 617 Architects and Builders Building, Indianapolis. Mr. Bingman has sold Jessop steels in the Indiana area since 1939.

George E. Markley has been appointed as sales manager of Radiant-Combustion, Inc. Formerly sales engineer of North American Manufacturing Company, manufacturers of combustion equipment and blowers, Mr. Markley will now center his attention on sales of Thermavol gas fired industrial furnaces which incorporate the new Thermavol burners.

Eugene J. Reardon, for two years general superintendent at New Haven, Connecticut, and Trenton, New Jersey, American Steel and Wire Company, Cleveland, has been appointed assistant chief engineer, with headquarters in Cleveland. He has been with the company since June, 1922. **Stephen B. Metcalfe,** superintendent at Trenton since August, 1938, succeeds Mr. Reardon at New Haven and Trenton. Mr. Metcalfe has been with American Steel and Wire since January, 1929. **Alexander J. King,** who has been with the company since 1922, has been made superintendent at the Trenton works, supplanting Mr. Metcalfe. Mr. King has been chief rope engineer at New Haven since September, 1939. **Bernard N. Carlson** will replace Mr. Metcalfe as chief rope engineer. He

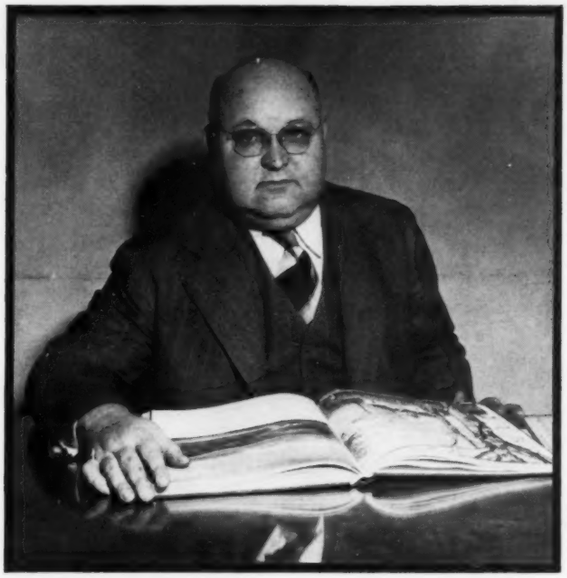
joined the company in 1929 and became wire rope engineer at New Haven in February, 1941.

Charles A. Reichelderfer has joined the research staff at Battelle Memorial Institute, Columbus, Ohio, and has been assigned to the division of nonferrous metallurgy. He formerly was associated with Jones and Laughlin Steel Corporation, Pittsburgh.

Jay T. Osler has been elected chairman of the board, Continental Roll and Steel Foundry Company, East Chicago, Indiana, to succeed the late Albert Pack. Mr. Osler will continue in his capacity as president. **John W. Hubbard,** chairman, Hubbard and Company, Pittsburgh, was elected a director to succeed Mr. Pack, and the board was increased from six to nine members. **G. N. Herman,** vice president in charge of sales, and **M. G. Sternberg,** vice president in charge of operations, Continental Roll and Steel Foundry Company, and **G. D. Patterson,** partner in the law firm of Winston, Strawn and Shaw, Chicago, were elected to the newly created posts.

Joseph H. Carter, operating vice president of the Sharon Steel Corporation, has been elected president of the Pittsburgh Steel Company. From 1916 to 1936, he was a Youngstown resident, going there as a slagger with the former Youngstown Iron and Steel Company at Lowellville, Ohio, in 1916. The next year the company was bought by Sharon Steel Hoop Company, and he began working up through the open hearth department, being made assistant superintendent in 1919, and open hearth superintendent two years later. In 1926 he was named assistant works superintendent, and four years later works superintendent. In March, 1936, he was transferred to Pittsburgh as general superintendent of the Pittsburgh Steel Company. Two years later he became operating vice-president of Pittsburgh Steel, and in May, 1940, was elected operating vice-president of the Sharon Steel Corporation, Sharon, Pennsylvania.

JOSEPH H. CARTER
"new president, Pittsburgh Steel Company"



WALTER E. BISLER
"will represent Pomona Pump Company in Pittsburgh district"

Walter E. Bisler, formerly sales engineer for the Combustion Engineering Company in the Pittsburgh district and connected with the Heine Boiler Company and the Combustion Engineering Company since 1920, has just accepted the position of district sales manager for the Pomona Pump Company. Mr. Bisler will maintain offices at Room 427, Grant Building, Pittsburgh, Pennsylvania. Mr. Bisler has been an associate member of the Association for many years taking an active interest in all of the organization's activities.

H. E. Grout has been appointed superintendent, small motor division, Westinghouse Electric and Manufacturing Company, Lima, Ohio. Joining the East Springfield, Massachusetts, works in 1925, he was transferred to Lima in 1937 as an inspection foreman, and subsequently became manufacturing foreman and general foreman.

Ralph H. Deihl, associated with the advertising department, the Falk Corporation, Milwaukee, for the past two years, has been appointed advertising manager of the company, effective January 1. Supervision of the advertising and sales promotion departments has been under **Walter L. Schneider,** vice president and director of sales, with **L. H. Billings** in charge, until recent transfer to other duties. Mr. Deihl was formerly in the advertising department of National Enameling and Stamping Company.

EC&M RIBBED CASE MAGNET

Ribbed
✓ FOR STRENGTH
✓ FOR COOL OPERATION

THIS ALL-PURPOSE LIFTING MAGNET (TYPE SA) SAVES *Time, Money, Space*

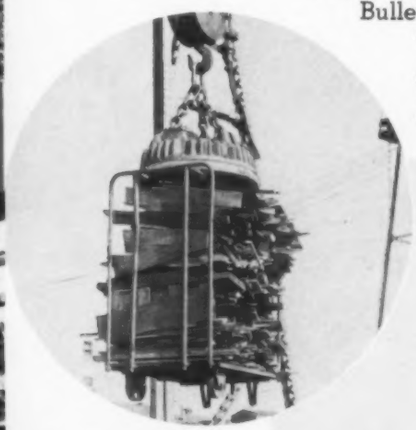
This magnet handles scrap quickly and easily. And when used for unloading, it sweeps the car bottoms clean.

★ Here's a "universal" magnet that you can use on almost any kind of magnetic materials handling job. It is strongly built (ribbed) to stand the hard jolts a magnet is bound to get. The ribs mean large radiation surface thereby maintaining high lifting capacity.

It saves money because of its high lifting capacity (1) per pound of weight, (2) per ampere of current and (3) per dollar invested.

A strong magnet for general use—one that handles material quickly and easily—and brings excellent returns on the investment. You should have all the facts about it. Ask for Bulletin 900 describing this universal Type SA and special types as well.

THE ELECTRIC CONTROLLER & MFG. CO., Cleveland, Ohio



No. 3½ Type SA Lifting Magnet conveying buggies of wood from ground level to cupola charging floor level. Also used to handle pig iron and castings at this foundry.

Handling both incoming and outgoing shipments of steel plates by an EC&M Type SA Lifting Magnet speeds up operations with safety. There is no lost time in prying apart plates to affix chains—no danger of crowbar or chain slippage. The skilled operator can lift a single plate or drop off a single plate as needed.

From stock pile to freight car—any magnetic material—any size—EC&M Type SA Lifting Magnet makes light work of it as shown in this job.

IMPROVED MAGNET OPERATION

WITH EC&M *Automatic-Discharge* CONTROLLER

FOR ALL SIZES AND TYPES OF MAGNETS

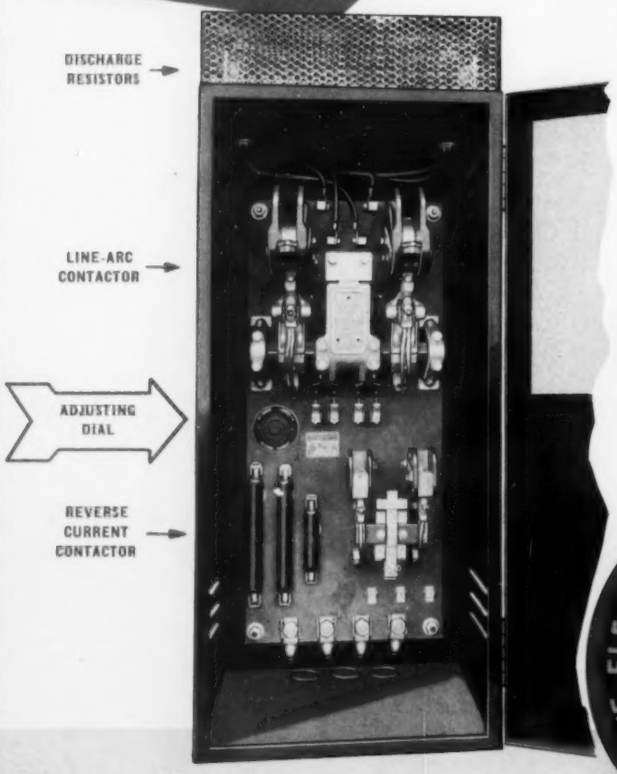
★ This *adjustable* magnet controller offers the feature of *automatic discharge* which guarantees a fast release of any load. It is *adjustable* to voltage, size of magnet or type of load. This is *exclusive* with the EC&M Magnet Controller.

Another valuable feature is its ability to keep *lifting capacity* at a high value all day long. Since reverse-current is turned off automatically, cooler magnet operation follows, thereby maintaining this higher lifting capacity.

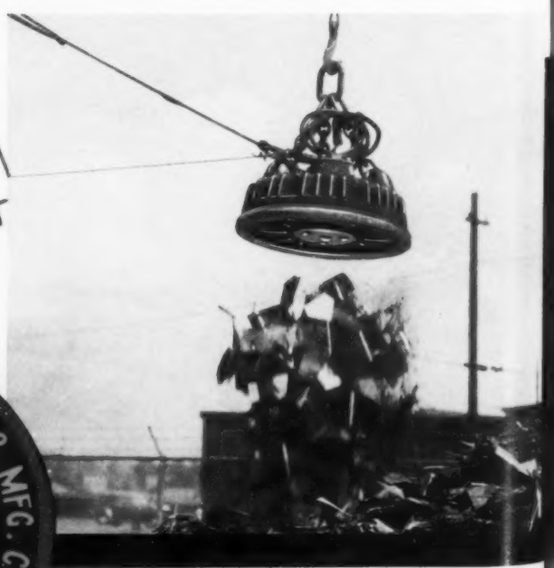
And *contacts last many times longer*—for the *LINE-ARC* principle controls the arc scientifically—at instant of opening, arc is transferred from contacts to arcing-plate and blow-out guard, assuring *cool contacts, longer life, lower upkeep.*

Ask for Bulletin AD giving complete data.

THE ELECTRIC CONTROLLER & MFG. CO.
Cleveland, Ohio



Used with single magnets or two or more magnets in parallel.



THE ELECTRIC CONTROLLER & MFG. CO. E&M CLEVELAND, OHIO

★

HEAVY DUTY MOTOR CONTROL FOR CRANE · MILL DRIVES AND MACHINERY · BRAKES · LIMIT STOP · LIFTING MAGNETS AND AUTOMATIC WELD TIME

Above: J. CLINTON PARKER, JR.
Right: DONALD M. McCLAIN

Donald M. McClain, formerly employed by the Republic Steel Corporation at their Warren, Ohio, plant, is now on duty as a captain with the 47th Engineers, U.S.A., serving at the Engineer Replacement Training Center at Fort Belvois, Virginia.

J. Clinton Parker, Jr., who was formerly associated with the Wean Engineering Company, of Warren, Ohio, is serving as first lieutenant, U.S.A., in the Engineer Replacement Training Center at Fort Leonard Wood, Missouri. Captain McClain and Lieutenant Parker are both graduates of Carnegie Institute of Technology.

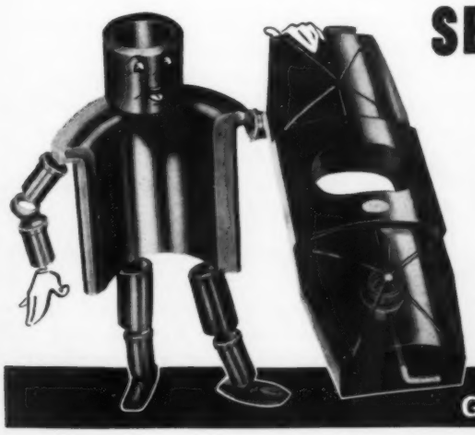
R. Howard Webster and **Richard J. Buck** of New York, **Warren W. York** of Allentown, Pennsylvania, and **W. Campbell Shaw** and **W. Colin Webster** of Montreal, has acquired an interest in the National Roll and Foundry Company, Avonmore, Pennsylvania, and now constitute, with **William H. Seaman** and **F. J. Kaib,** the Board of Directors of the company.

R. Howard Webster is Chairman of the Board. Mr. Seaman remains president and general manager. Warren W. York and Richard J. Buck are vice presidents, and Mr. Kaib continues as secretary and treasurer.

The company, which is engaged in the manufacture of iron and iron alloy rolls, was founded in 1909.

Charles R. Miller, Jr., formerly director of purchases, has been elected as vice president—purchases, United States Steel Corporation of Delaware, and a member of its executive committee and board of directors, effective January 1, 1942.

Mr. Miller, born in Pittsburgh, Pennsylvania, has been associated with United States Steel subsidiaries for more than 44 years, first entering the employ of the Carnegie Steel Company as an office boy in 1897. Subsequently he served as an order clerk, bill clerk, and shipping clerk in the purchasing department of the Carnegie Steel Company until May 1, 1918, when he was promoted to purchasing agent of the Carnegie Steel Company. On January 1, 1935, when the Carnegie-Illinois Steel Corporation was organized, he was made purchasing agent for the Pittsburgh District with headquarters in Pittsburgh, Pennsylvania. On August 15, 1940 he was appointed director of purchases, United States Steel Corporation of Delaware, with headquarters at its Pittsburgh office, which position he has held until his election as vice-president.



SELF-ALYN SLIPPER BEARINGS

The GATKE Invention that Revolutionized Universal Coupling Performance . . .

- **10 times longer service.**
- **Eliminate Socket Scoring and Wear.**
- ***Avoid costly machine shop work.***
- **End destructive vibration.**
- **Stop pounding noises.**
- **Prevent Grease slinging.**
- **Made to fit without machining for all sizes and types of UNIVERSAL COUPLINGS.**
- **Information on request.**

Gatke MOULDED FABRIC Bearings

GATKE CORPORATION - 228 N. La Salle - CHICAGO

Max W. Babb, president of Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin, was elected Chairman of the Board of Directors, and **W. C. Buchanan,** a director and member of the Executive Committee, was elected to succeed him as company president.

Mr. Buchanan has for the past six years devoted a substantial portion of his time to the Globe Steel Tubes Company, in Milwaukee, of which he is president, and in which capacity he will continue.

Mr. Babb in becoming Chairman of the Board will fill the position formerly occupied by the late General Otto H. Falk, which has been vacant since his death in 1940.

These changes in management were made in order to further improve the company's position, with particular reference to production, as heavy and increasing demands are being made on its facilities in connection with the Nations' war work.

F. J. Carr has been elected vice-president, finance, of American Steel and Wire Company, Cleveland, Ohio, subsidiary of United States Steel Corporation.

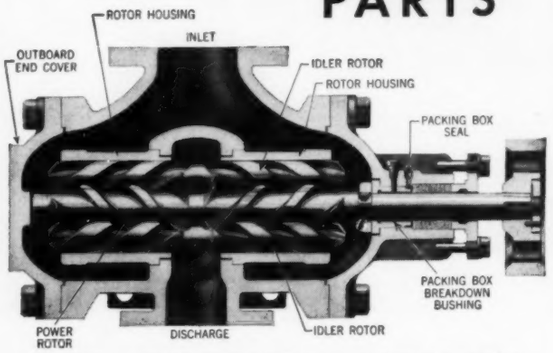
At the same time, **C. S. Morris** is appointed supervisor of accounting and **Ogden Ashley** is made assistant to vice-president, finance.

Mr. Carr's association with American Steel and Wire began in March, 1938, when he was appointed to the post of assistant to the president. The following October he was named comptroller of the company.

Prior to becoming associated with American Steel and Wire, Mr. Carr served for four years as comptroller of the Tennessee Valley Authority at Knoxville, Tennessee. Previous to that he had been comptroller of Aviation Corporation, after having held a similar position with Hahn Department Stores.

WILLIAM D. CLEAVENGER

Only 3 MOVING PARTS



The DE LAVAL-IMO Oil Pump consists of a casing enclosing a power rotor and two idler rotors. There are no valves, no timing gears, no separate bearings, and only one stuffing box, which is under suction pressure. All parts are in perfect rotary and hydraulic balance and the delivery is continuous and uniform, as from a piston moving steadily in one direction. There is no vibration or pulsation. IMO pumps run at motor or turbine speeds and handle all oils in all quantities against all pressures.

Ask for Catalog 1-79

IMO PUMP DIVISION
of the De Laval Steam Turbine Co.
Trenton, New Jersey

OBITUARIES

William D. Cleavenger, superintendent, Mechanical Department, Youngstown Sheet and Tube Company, East Chicago, Indiana, died recently. He had been at the head of the plant's large mechanical group for 20 years. His death ended a life-long career in the mechanical field in which he was highly successful. Born at Monongahela, Pennsylvania, he worked in steel mills from his youth. Previous to going to Youngstown Sheet and Tube, he had been an executive of the Upson Nut Company at Cleveland.

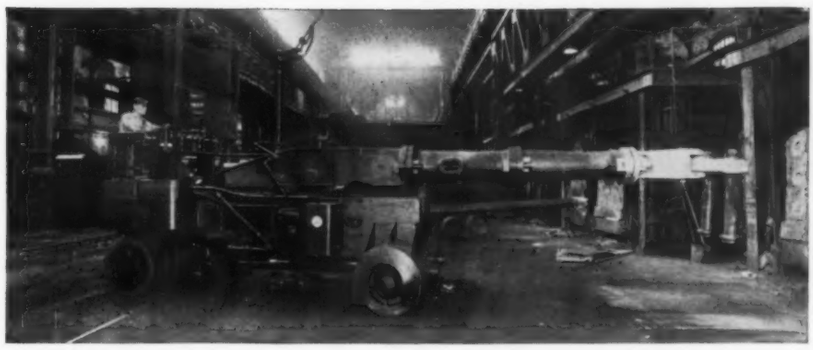
Mr. Cleavenger had been a member of the Association of Iron and Steel Engineers since 1933.

G. Cook Kimball, executive vice president, United States Steel Corporation of Delaware, died in Chicago, Illinois, January 12, after a long illness.

Mr. Kimball, who was 62 years old, had spent his entire business career in the steel industry, beginning as an engineer with American Tin Plate Company in 1901, after his graduation from Harvard University. He was executive vice president, Carnegie-Illinois Steel Corporation, from 1935 until April, 1939.

Harry A. Trebing, 64, former analytical chemist, Corrigan, McKinney Steel Company, now part of Republic Steel Corporation, Cleveland, died unexpectedly at his home in Baltimore. For the past ten years Mr. Trebing had been manufacturers representative in the East for companies including the Smith Facing and Supply Company, Cleveland.

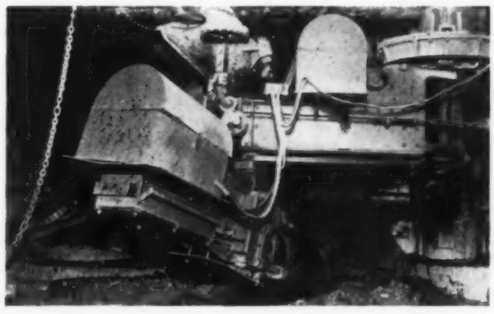
Boost Output for *Defense*



Brosius Auto Floor Machines, arranged to handle charging boxes for charging melting furnaces; equipped with tongs for serving heating furnaces, mills, hammers, presses, etc.; and designed as manipulators for manipulating pieces under hammers, and presses, as well as charging and drawing the heating furnaces.

They are self contained, require no tracks or expensive runways, and their movement is not restricted to any definite path. No provision, aside from a good floor on which to operate, is necessary for their installation.

Built in capacities of from 2000 lb to 20,000 lb, we can offer a machine to meet most any charging or manipulating problem.



Brosius Clay Gun Equipment is either Column (as shown) or Pedestal Mounted. On both types of mountings the gun is swung into and out of the tapping hole by means of an individual motor. The worm and spur gear drive is positive and the gun travels into and out of the tapping hole at a uniform speed.

The gun proper is of the same design for both types of mountings and the clay piston is driven by individual motor through a rack, pinions, and a worm gear reduction.

Brosius Goggle Valves are equipped with a double drive, one for opening and closing seats, and one for swinging the plate. The latter drive may be either hand or motor operated. Each valve seat is flexible so as to conform to any slight distortion of the valve due to stresses in the gas main, thus maintaining a tight valve at all times. The valves are self contained and independent of the gas line in their operation. A full opening of the gas line is obtained as there are no operating parts of the valve in the gas stream, all working parts being on the outside of the valve and easily accessible.

Edgar E. **BROSIUS** *Company*

MANUFACTURERS AND DESIGNERS OF SPECIAL EQUIPMENT FOR BLAST FURNACES AND STEEL MILLS

PITTSBURGH, SHARPSBURG BRANCH, PA.

Brosius Equipment is covered by patents allowed and pending in the United States and Foreign Countries

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Lubrication Engineer
Bethlehem Steel Company
Saucon Division
Bethlehem, Pennsylvania

J. W. Gore
Electrical Department
Bethlehem Steel Company
Shipbuilding Division
Baltimore, Maryland

A. H. Olson
Master Mechanic
American Steel and Wire Company
Cleveland, Ohio

C. E. S. Eddie
Lubrication Engineer
Great Lakes Steel Corporation
Ecorse, Michigan

C. H. Manion
Vice-President in Charge of Operations
Follansbee Steel Corporation
Follansbee, West Virginia

H. W. Campbell
Plant Engineer
Interlake Iron Corporation
Toledo Furnace Plant
Toledo, Ohio

E. H. D. Gibbs
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Homestead Steel Works
Munhall, Pennsylvania

C. W. Crosby
Engineer
American Steel and Wire Company
Cleveland, Ohio

J. F. Wilbur
Superintendent
Steam and Combustion Department
Bethlehem Steel Company
Johnstown, Pennsylvania

R. George Russell
Soaking Pit Foreman
Carnegie-Illinois Steel Corporation
Clairton, Pennsylvania

Edward W. Hopper
Superintendent Tin Plate Department
Pittsburgh Crucible Division
Crucible Steel Company of America
Midland, Pennsylvania

R. R. Underwood
Chief Inspector and Expeditor
Jones and Laughling Steel Corporation
Pittsburgh, Pennsylvania

R. F. R. de Azevedo
Engineer
National Steel Company of Brazil
Cleveland, Ohio

A. S. T. Filho
Metallurgical Engineer
National Steel Company of Brazil
Cleveland, Ohio

S. Landen
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Carnegie-Illinois Steel Corporation
Gary Works
Gary, Indiana

T. J. Jones
Superintendent Transportation and Labor
Wheeling Steel Corporation
Steubenville, Ohio

E. G. Weston
Assistant Chief Engineer
Wheeling Steel Corporation
Steubenville, Ohio

Junior

J. Ganzar
Special Engineer
Bloomer, Slab and Plate Mills
Carnegie-Illinois Steel Corporation
Gary, Indiana

Associate

A. B. Powell
Sales Engineer
Mason-Neilan Regulator Company
Pittsburgh, Pennsylvania

A. N. Powell
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Valve Department
American Car and Foundry Company
Lexington, Kentucky

H. H. Howard
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Crocker-Wheeler Electric Mfg. Company
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Hammond, Indiana

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Elwell-Parker Electric Company
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Automatic Transportation Company
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W. P. Tryon
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A. P. Green Fire Brick Company
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H. A. Brassert Company
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Bedford Foundry & Machine Company
INCORPORATED
ENGINEERS, MANUFACTURERS AND FABRICATORS
ELECTRIC TRAVELING CRANES
STONE WORKING MACHINERY
STEEL STRUCTURES
STEEL DERRICKS
GENERAL OFFICE
Bedford, Indiana

A Typical Wagner Hydraulic Bridge Brake Installation.

Another Crane Manufacturer Standardizes on . . .

WAGNER
HYDRAULIC
BRIDGE BRAKES

Industrial crane manufacturers exert every effort in producing cranes that will give top operating performance.

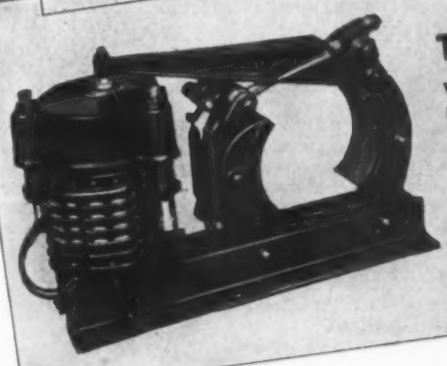
Brakes are a major factor to consider in assuring users of the highest possible crane operating efficiency.

Because Wagner Hydraulic Bridge Brakes give sure positive braking action, smooth stopping and controllable deceleration under the most severe operating conditions, they have been adopted as standard by The Bedford Foundry and Machine Company . . . Here are a few of the outstanding features that make Wagner Bridge Brakes the first choice of Crane Manufacturers:

1. Easy one-point adjustment . . . **2.** Exclusive anti-drag device . . . **3.** They have hardened pins, knurled to prevent rotation . . . **4.** They have bushings at points of maximum wear . . . **5.** Grease fittings are provided on all hinge pins . . . **6.** The friction blocks are extra thick and bolted to the shoes . . . **7.** They are built by a manufacturer of Lockheed hydraulic brakes . . . **8.** Wagner provides nation-wide service through twenty-five branches.

2 This is the second of a series of advertisements designed to acquaint crane users with a few of the many crane manufacturers who are now standardizing on Wagner Hydraulic Bridge Brakes.

TYPE H
Wagner hydraulically actuated bridge brake for inside cranes.



TYPE HM
Wagner hydraulically actuated bridge brake with automatic parking attachment for outside cranes.

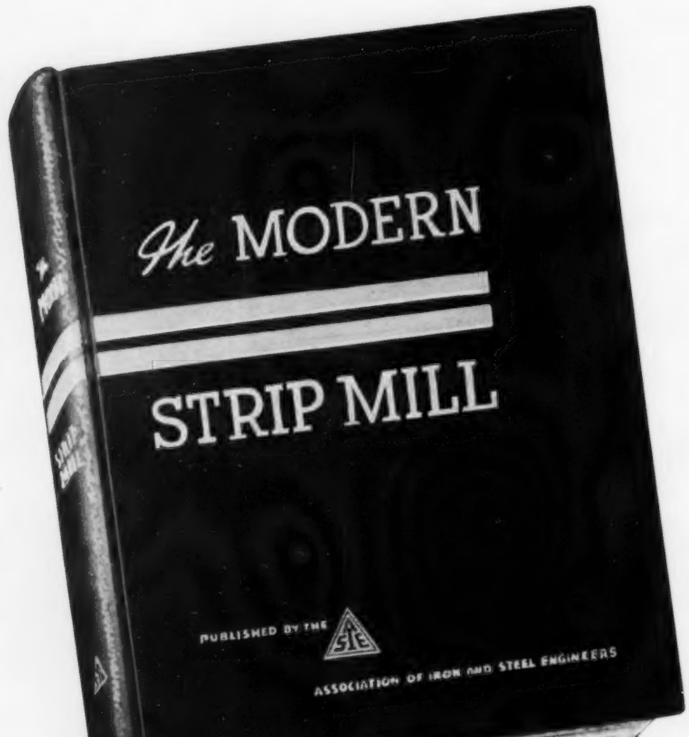
M2

Send FOR BULLETIN IU-20.

Every production, safety and maintenance superintendent should have this valuable bulletin. It completely describes Wagner Hydraulic Bridge Brakes. Write for your FREE copy today.

Wagner Electric Corporation
6400 Plymouth Avenue, Saint Louis, Mo., U.S.A.
BRAKES • MOTORS • TRANSFORMERS • FANS

FOR STEEL PLANT ENGINEERS



The Modern Strip Mill, published by the Association of Iron and Steel Engineers, is a complete recording of the installations and practices of the 28 wide continuous strip mills in the United States. The book represents the first handbook presentation of any branch of the steel industry, and the information contained is available from no other single source.

Great care has been exercised in the preparation of this work so that information contained therein will be of permanent value. Strip mill practice, as followed in the wide strip mills in the United States, has been carefully described in the first part. In the second part, available data on all of the 28 individual installations have been tabulated in a thorough and complete manner. Contained within each section is detailed catalogue information that has been prepared by the suppliers of steel mill equipment and services.

The book has been distributed to A. I. S. E. members, and a limited number of copies are now available for sale to those interested. Concessions are offered to new members. For complete information, write A. I. S. E. headquarters.

"THE MODERN STRIP MILL"

PART I—Equipment and Process

SECTION I—GENERAL
Product—History—Installations—Capacity—Steel quality—Process—Selection of mill size.

SECTION II—SLAB HEATING
Slab yard—Slab heating furnaces—Depiler—Charging table—Pusher.

SECTION III—HOT STRIP MILL
Stand spacing—Roughing scalebreaker—Roughing stands—Turntables—Slab pusher—Slab squeezer—Edgers—Universal roughers—Crop shears—Finishing train—Mill speeds—Loopers—Screwdown—Roll balance—Guides—Drafting—Strip temperature—Rolling pressure—Hot mill operation—Disposal of product—Flying shears—Coilers—Mill tables—Descaling.

SECTION IV—MILL PARTS AND ACCESSORIES
Housings—Rolls—Roll changing—Cold mill roll grinding—Gear sets—Lubrication—Bearings.

SECTION V—ELECTRICAL EQUIPMENT
Rolling power calculations—Energy saving—Mill drives—Motor room design—Motor room ventilation—Power supply.

SECTION VI—PICKLING
Continuous pickling lines—Batch pickling.

SECTION VII—COLD MILLS
Tandem mills—Reversing mills—Reductions—Maintenance of gauge—Strip tension—Mill speed—Coolant—Rolling power calculations—Data from typical mills—Temper mills.

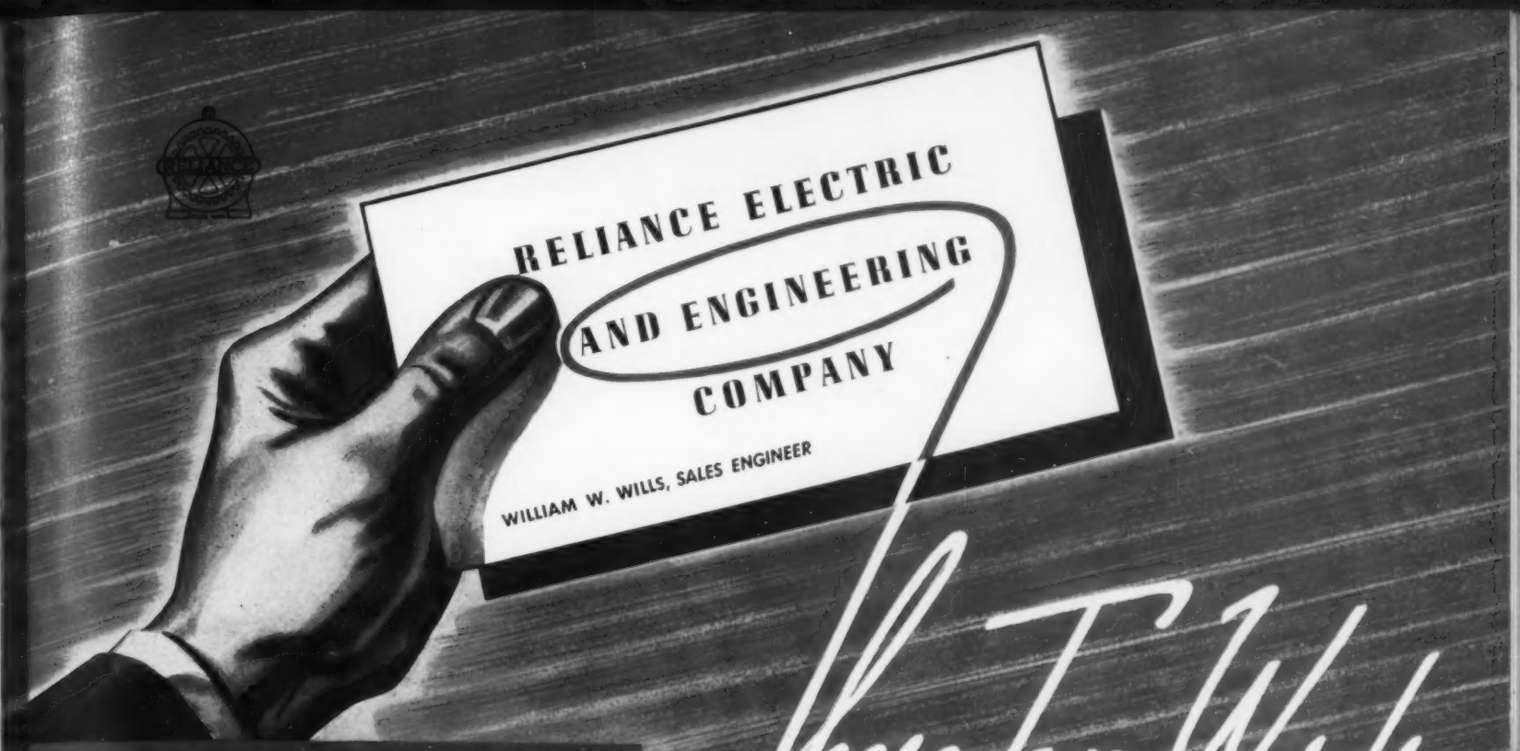
SECTION VIII—HEAT TREATING
Annealing—Normalizing.

SECTION IX—PROCESSING AND MATERIAL HANDLING
Shearing, etc.—Galvanizing—Electrolytic cleaning—Tinning—Cranes—Trucks—Conveyors.

PART II—Mill Descriptions

This part contains available data on each of the 28 wide strip mills installed in the United States. Complete tabulations and mill layouts are included.

THE ASSOCIATION OF IRON AND STEEL ENGINEERS
1010 EMPIRE BUILDING, PITTSBURGH, PA.



These Two Words

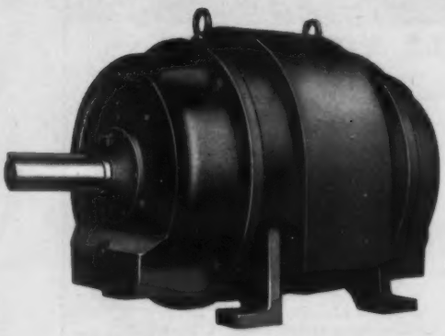
MAKE *MOTOR-DRIVE* *MORE THAN* POWER!

Motor-drive provides within itself a means of:

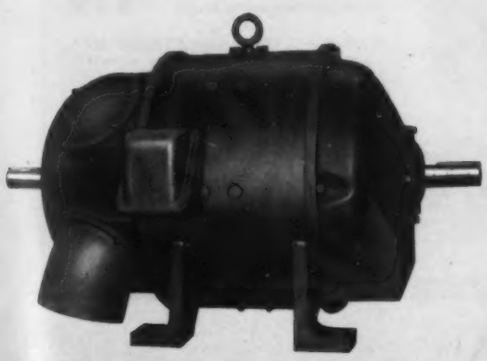
Speed Control	Reversing
Braking	Remote Control
Tandem Operation	Controlled Acceleration
Tension Control	Safety

Slow Speeds for inching, threading, inspection

Applying them to boost production and improve quality is APPLICATION ENGINEERING. That's our business.



Splash-proof Type AA Squirrel-cage A-c. Induction Motor with ball bearings.



Splash-proof Type T D-c. Reliance Motor with ball bearings.

The man who sends this Reliance card to you is skilled in Application Engineering. He is prepared to discuss motor-drive as a means for boosting production and improving the quality of the products made in your plant. He represents an organization whose "bread and butter" for 35 years has come from showing industry how electric motors can be used profitably to do *many things* besides turn shafts and gears. To get the most from these production aids call in a Reliance man when your plans are in the early stages. He can help make motor-drive an integral part of your production equipment and not an appendage. No obligation, of course.

RELIANCE ELECTRIC & ENGINEERING CO.
1088 Ivanhoe Road • • • Cleveland, Ohio

BIRMINGHAM • BOSTON • BUFFALO • CHICAGO • CINCINNATI • DETROIT • GREENVILLE, S. C.
HOUSTON, TEX. • LOS ANGELES • MINNEAPOLIS • NEW YORK • PHILADELPHIA • PITTSBURGH
PORTLAND, ORE. • ST. LOUIS • SAN FRANCISCO • SYRACUSE, N. Y. • and other Principal Cities

RELIANCE A-C D-C MOTORS

SPEED UP WAR PRODUCTION!

EQUIP ALL MACHINES WITH LINCOLN CENTRO-MATIC LUBRICATING SYSTEMS

1. Large punch press with Lincoln Centro-Matic System—push button control lubricant pump. (Model 1840)
2. Small shears with Lincoln Centro-Matic System—hand operated lubricant pump. (Model 1805)
3. Massive press with Lincoln Centro-Matic System—full automatic control lubricant pump. (Model 1787)

FULL speed ahead—7 days and nights a week—on war production is the aim of all industry today. To keep production rolling at top speed, proper lubrication of bearings on all machinery and mechanical equipment is a factor of vital importance.

You can depend on Lincoln Centro-Matic Lubricating Systems to provide fast, positive and economical lubrication of all bearings and minimize shut-down time due to bearing failure. The system is easy to install and consists of a number of Centro-Matic injectors,—one for each bearing, each individually adjusted to deliver the required amount of lubricant, under pressure, to the bearing. Lubricant is pumped from a central pumping unit, which can be either hand-operated, semi-automatic or entirely automatic with time clock control.

The Lincoln Centro-Matic System has almost no limitations—it can be applied to all types of machinery regardless of the number of bearings to be lubricated.

SEND FOR FREE COPY OF BULLETIN 888

or send us specifications of the machinery to be lubricated and our engineers will gladly make recommendations. No obligation.

142-1

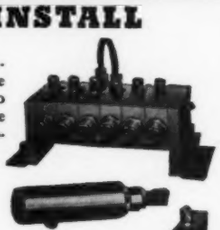
LINCOLN ENGINEERING COMPANY

Pioneer Builders of Engineered Lubricating Equipment

ST. LOUIS, MISSOURI

SIMPLE TO INSTALL

Lincoln Model 1787 Air motor operated, 400-lb. drum pump. Pumps lubricant direct from original refinery container and is full automatic with time clock control.

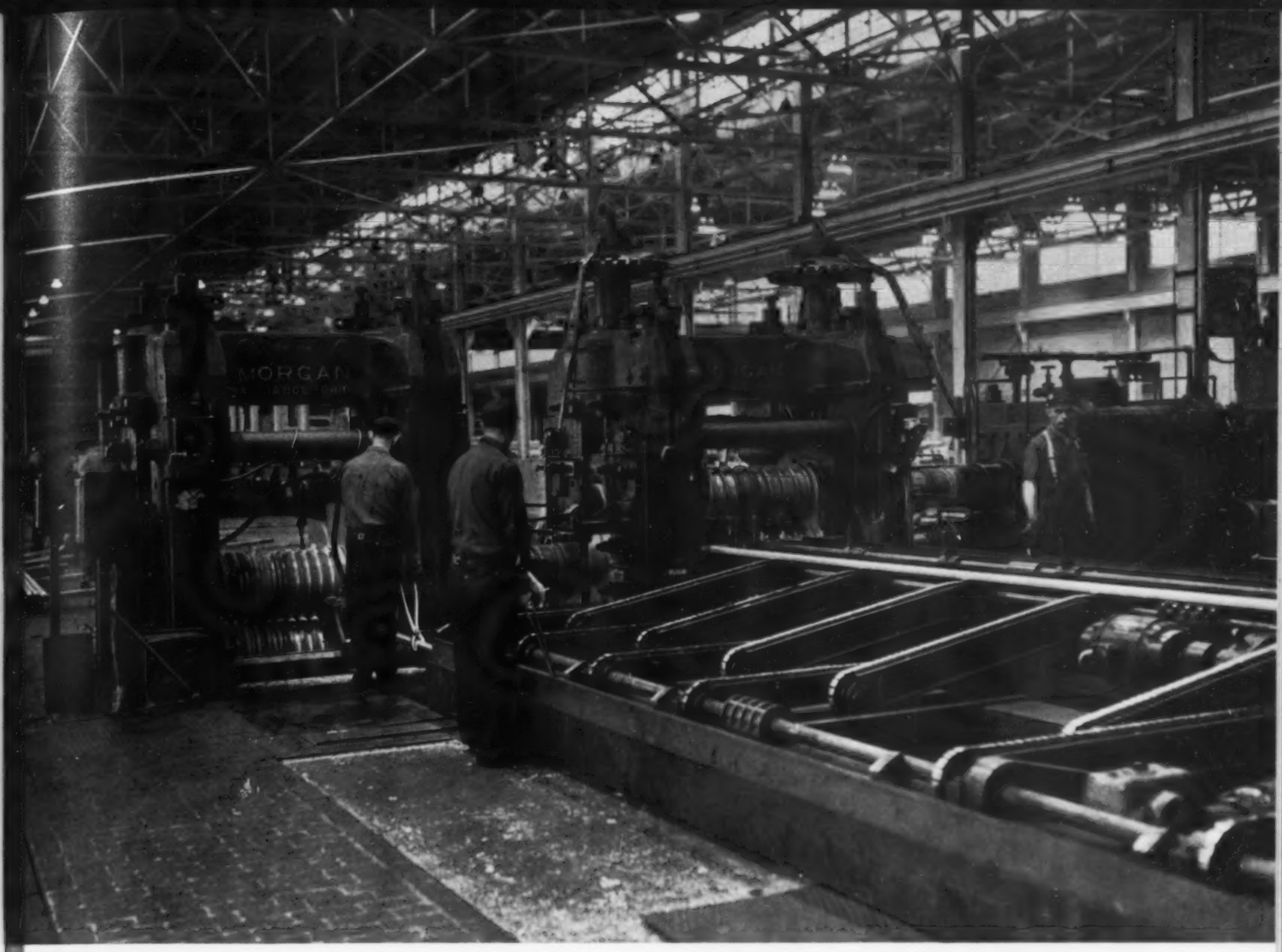


Lincoln Centro-Matic injectors are furnished in two types—block type for manifold grouping. Cylindrical type for widely spaced bearings.

Lincoln grease line accessories—high-pressure fittings and adapters, connectors, connector tube assemblies, compression couplers, bushings and lubricant hose.

Lincoln Model 1840 fully-automatic electric Lubrigun, 30-lb. capacity.

Lincoln Model 1805, Manually operated Centro-Matic Pump, 2-lb. capacity.



BUILT BY MORGAN *Engineering*

ROLLING ALUMINUM FOR DEFENSE

● Among the many types of mill equipment built by Morgan, is the above mill consisting of two 22″ and two 18″ 3-high stands driven by one 22″ 3-high and one 18″ 3-high pinion stand, for rolling aluminum shapes. With this installation was furnished three oil hydraulic cropping and cutting-off shears to handle up to 5″ x 5″ aluminum billets. On such equipment for maximum production, the rugged stability of Morgan Engineering is well established, long since proved by the largest producers.

DESIGNERS • MANUFACTURERS • CONTRACTORS

BLOOMING MILLS • PLATE MILLS • STRUCTURAL MILLS
ELECTRIC TRAVELING CRANES • CHARGING MACHINES
INGOT STRIPPING MACHINES • SOAKING PIT CRANES
ELECTRIC WELDED FABRICATION • LADLE CRANES
STEAM HAMMERS • STEAM HYDRAULIC FORGING
PRESSES • SPECIAL MACHINERY FOR STEEL MILLS

THE MORGAN ENGINEERING CO., Alliance, Ohio
Pittsburgh, 1420 Oliver Building

THE MORGAN ENGINEERING CO.
ALLIANCE, OHIO Pittsburgh, 1420 Oliver Bldg.

NEW STAMCO AUTOMATIC PLATE SHEAR

Another STAMCO triumph. A specially designed automatic shear to resquare armor plate.

With the defense program under way, each day brings new demands of ***STAMCO.*** To fill a new need, ***STAMCO*** engineers have designed and perfected this outstanding unit for shearing heavy armor plate in conjunction with sheets.

This automatic ***STAMCO*** shear has a capacity for plate up to ⅝" thick by 156" long. It is built in various sizes to meet individual requirements. ***STAMCO*** engineers will gladly help you with your sheet and plate shearing problems.

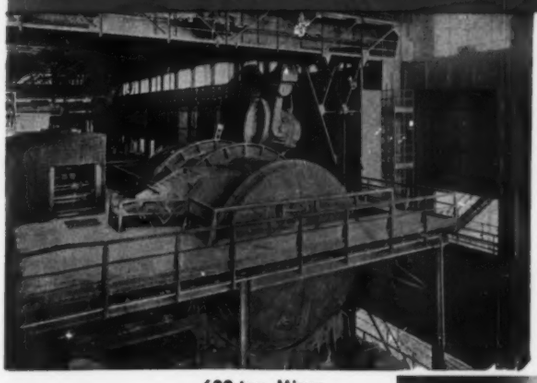
LAY YOUR SHEARING PROBLEMS AT STAMCO'S DOOR

The STREINE TOOL & MANUFACTURING COMPANY

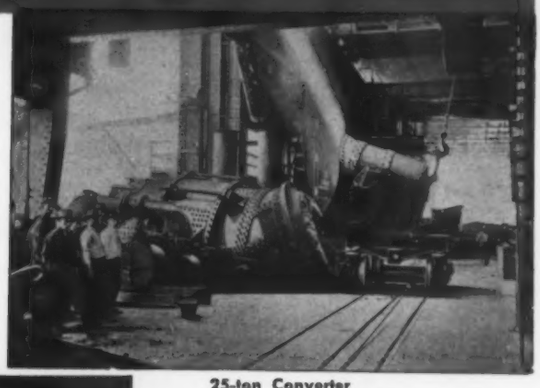
STAMCO

NEW BREMEN, OHIO, U.S.A.

CONVERTERS, MIXERS
TILTING OPEN HEARTH FURNACES
DUPLEX STEEL PLANTS



600-ton Mixer



25-ton Converter

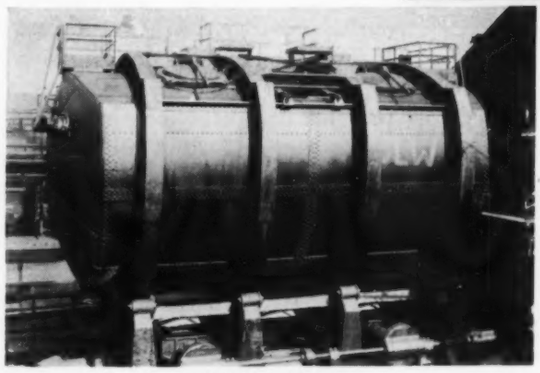
These pictures give but small evidence of Pennsylvania Engineering Works' contribution to the Steel Industry.

Backed by many years of experience and the great number of installations in the many Steel Plants, the Pennsylvania Engineering Works is prepared to design, fabricate and erect complete Duplex Plants, including Mixers —25 tons to 2000 tons capacity, Open Hearth Furnaces—50 tons to 400 tons capacity—both tilting and stationary, Coverters—5 to 50 tons capacity, Converter Jack Cars, Bottom Oven Cars, Regulating Valves, Slag Cars, Ladles, Ladle Cars, Transfer Cars, Jib Cranes and Hauling Systems.

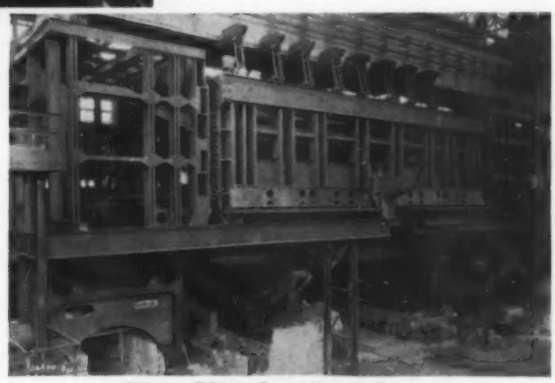
Blowing Charge in 15-ton Converter

Installations of some of the illustrated equipment at

Inland Steel Company
Tennessee Coal, Iron & Railroad Company
Youngstown Sheet & Tube Company
Carnegie-Illinois Steel Corporation
Republic Steel Corporation
Bethlehem Steel Company
American Steel & Wire Company
Weirton Steel Company
Jones & Laughlin Steel Corporation
Ford Motor Company, River Rouge
Ford Motor Company, England
Broken Hill Proprietary Company, Australia
Tata Iron & Steel Company, India
Algoma Steel Company, Canada
Steel Company of Canada, Ltd.
Compania Siderurgica del Mediterraneo, Spain
Cia. Fundidora de Fierro y Acero, Mexico



1500-ton Mixer



400-ton Tilting Open Hearth Furnace

Pennsylvania Engineering Works
New Castle, Penna.

THE MOST INSIDIOUS SABOTEUR IN YOUR PLANT... WATER!

RIDDLED BY CORROSION.
This 4-inch pipe in a steel mill corroded so badly that it had to be replaced in 6 months. Don't let this happen in your plant. Control corrosion and prevent scale with Calgon.

PLAIN water enters your plant as a friend, yet it causes millions of dollars worth of damage to industry yearly. Hard water clogs your pipes and equipment with scale. Soft water causes serious corrosion which destroys equipment as effectively as sabotage.

In steel-mill cooling systems, scale causes open-hearth doors to overheat, warp and crack. It gets in the jackets of blast furnaces and results in costly repair jobs. It plugs condensers, ammonia scrubbers, and water jackets of electric furnaces. Scale causes frequent and costly shutdowns and production losses that can never be regained.

Corrosion is even more deadly in effect. Damages are more extensive, replacements are costlier, and new equipment is difficult if not impossible to obtain.

Calgon Treatment prevents scale and controls corrosion

A simple, inexpensive treatment of 2-5 ppm. of Calgon in your cooling system will prevent scale and reduce corrosion to such an extent that it ceases to be a serious problem.

Calgon* Treatment has been thoroughly proved over a period of years. It saves thousands of dollars yearly by increasing the life of equipment, preventing shutdowns, increasing production and eliminating costly maintenance. Send the coupon for complete information TODAY.

**Calgon is the registered trade-mark of Calgon, Inc. for its glassy sodium phosphate products.*

calgon, inc.
300 ROSS ST. PITTSBURGH, PA.

Calgon, Inc.
300 Ross Street, Pittsburgh, Pa.
Gentlemen:
Send technical literature on Calgon for controlling scale ☐ or corrosion ☐ in cooling systems.
Name_____
Company_____
Address_____
City_____ State_____

Automatic
SAFE-T-TONGS

Looking for speed-up methods to meet today's requirements? Here's the answer for any plant that handles materials by crane or hoist.

With no more manipulation than dropping them on the work, Heppenstall Automatic Safe-T-Tongs, which operate mechanically, go through the entire cycle of pick-up, carry, and release without depending on electricity or any other means of power. The automatic locking device is simple—there is nothing to get out of order, therefore they never need repairs.

Crane men can operate Heppenstall Automatic Safe-T-Tongs with only a few minutes' instruction. No more rigging of slings or chains on the burden to be lifted. Dangerous close work by ground men is eliminated.

Heppenstall engineers will gladly cooperate in developing special tongs to solve your handling problem, no matter how unusual it happens to be. Add safety and economy to your operation—save time when you need it most. Use Heppenstall Automatic Safe-T-Tongs, their benefits are proven by thousands of applications from coast to coast. Write for new 24 page Engineering Catalog. No charge—no obligations. Address, Box E-1 Automatic Safe-T-Tongs Sales Department, Heppenstall Company, Pittsburgh, Pennsylvania.

HEPPENSTALL
Heppenstall has the Experience
QUALITY

Heppenstall Company

PITTSBURGH, PENNSYLVANIA

For Accurate and Easily Adjustable Timing Intervals

This Heavy Duty Electronic Timer provides accurate and easily adjustable time intervals in electric control circuits. It opens or closes a contact on adjustable time after a separate actuating device functions.

FEATURES

20 to 1 Timing Range with stepless adjustment.

Instantaneous re-setting after operation.

Very accurate timing over the range.

Practically unaffected by Voltage changes over NEMA allowable ranges.

Contact capacity maximum 170 Watts, which is large enough for Relays or Contactors below 50 ampere size. (In larger capacity requirements, a Microswitch having a capacity of 10 amperes at 115V, 5 amperes at 230V may be supplied).

Frequency 50 or 60 cycles.

Each device can be operated from 115V or 230V.

No moving parts except relay.

Telephone Type Relay standard.

Fully descriptive "3C" Bulletin 7313, Type ET Electronic Time Delay Relay available on request

OFFICES IN PRINCIPAL CITIES

THE CLARK CONTROLLER CO.

1146 EAST 152ND ST. CLEVELAND, OHIO

"So—when we built our new Eastern plant—we installed more Clevelands"

"Most of our machines since 1925 have been operated by Cleveland Worm Gear Speed Reducers and in 16 years we have never had a machine shutdown due to failure of the Drives.

"Many of these 75 Drives are operating on equipment where a failure would mean shutting down a large portion of the plant."

When this West Coast Corporation expanded into the East they looked into their own records of speed reducer performance—and then bought more Clevelands!

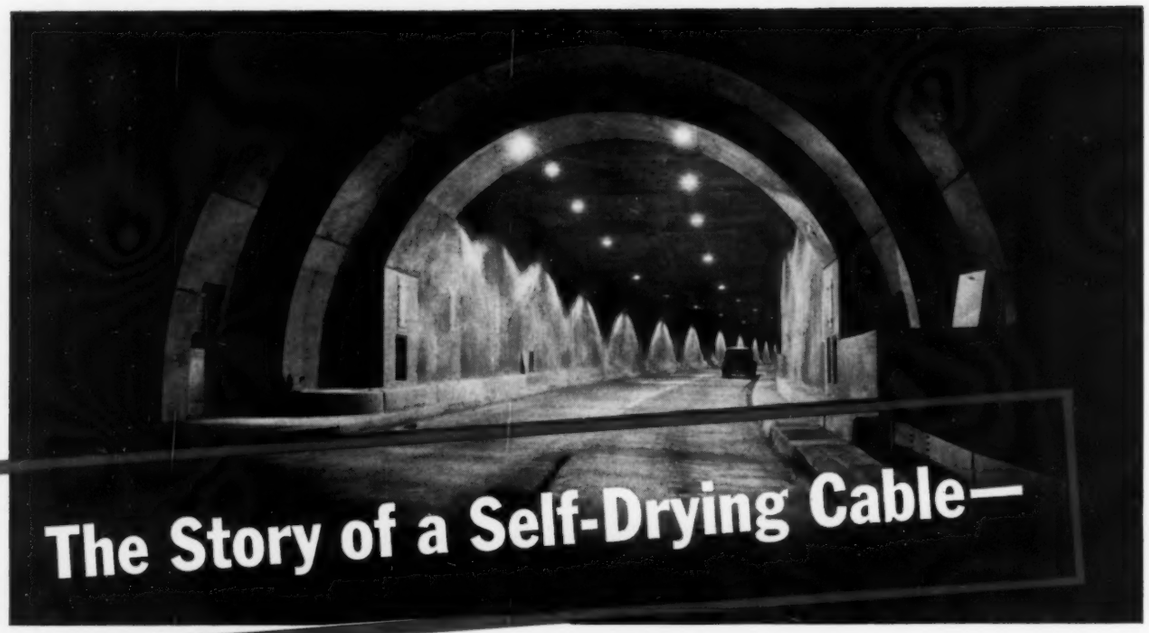
What better assurance can *you* ask than the record of long life and trouble-free operation that Clevelands have established in the heavy industries throughout North America?

The Cleveland Worm & Gear Company, 3278 East 80th Street, Cleveland, Ohio.

Affiliate: The Farval Corporation, Cleveland, Manufacturers of Centralized Systems of Lubrication.

In Canada: PEACOCK BROTHERS LIMITED

CLEVELAND WORM GEAR *Speed Reducers*



The Story of a Self-Drying Cable—

HOW OKONITE ENGINEERS HELPED TO PROVIDE UNFAILING LIGHT FOR THE WORLD'S MOST MODERN HIGHWAY

THE PROBLEM

Pennsylvania Turnpike Engineers required a cable for mercury vapor lamp leads capable of withstanding the extremely high heat encountered and also capable of supplying unfailing service even after possible exposure to corrosive mine waters (a condition likely to be encountered in event of a prolonged outage). The conductors had to be highly corrosion-resistant as well.

Mercury vapor lamp unit with Okoglass cable lead

The problem was further complicated by the fact that the assembled lighting unit must be periodically removed for cleaning. This necessitated a cable that could withstand repeated flexing. This combination of requirements ruled out the possibility of using any organic insulation and made a pioneering approach essential.

THE SOLUTION—Okonite engineers were consulted and their pioneer development work done years ago on fiber glass proved to be invaluable. This original research had led to revolutionary designs in heat-resisting cables and brought great improvements to windings for high-temperature electric motors.

Application of the findings of this work to the new problem resulted in a cable construction which consisted of fiber glass insulation and glass braids over an Okoloy-protected copper conductor with aluminum basketweave outer covering. The aluminum sheath was used as the return path for the lamp circuit.

Okoglass-insulated "self-drying" cable

THE PROOF

Test (1) 24" length of cable supported in air at temperatures between 212° and 250°. Tap water dripped on the cable at rate of one drop every 20 seconds. No observable effect on operation; ammeter at lamp showed a reduction in current through the lamp of less than 1/3 of 1%.

Test (2) 24" length of cable immersed in tap water for 23 hours was connected to operate an AH-5 mercury lamp. When power was applied, the cable began to heat up and steam appeared surrounding it. After 2 minutes, the light flashed on and went out. This cycle repeated with longer "on" periods until, after the fourth flash, the light stayed on. Self drying was complete; the cable cooled down to room temperature and appeared perfectly dry.

THE CONCLUSION

". . . the proposed cable . . . is fundamentally correct".
—Arthur J. Sweet

—In the words of Arthur J. Sweet, noted lighting expert, who was consultant for the Turnpike authorities and who suggested the basic design of the cable . . . "I regard the tests as establishing that the proposed cable construction is fundamentally correct for the projected service . . . On behalf of my client, I wish to express the most cordial appreciation of your courtesy in making up to our tentative specifications, a 50-foot sample . . . and in affording us the facilities of your laboratory and the invaluable assistance of your men in testing this cable."

AN INVITATION—You, too, may need a cable to overcome some difficult operating condition. Why not ask Our Engineering Service Department to work with you in finding the right solution?

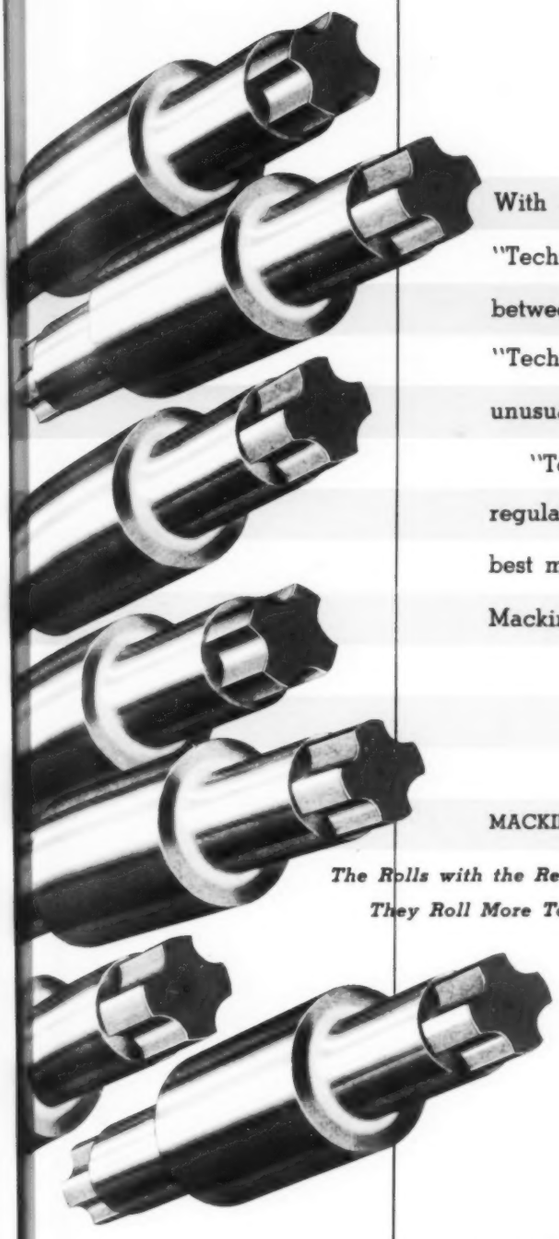
THE OKONITE COMPANY
PASSAIC, NEW JERSEY
Offices in principal cities

OKONITE
Insulated Wires & Cables

For greater production

from your Rod, Merchant

and Bar Mills . . . .



With all stands of your Rod, Merchant and Bar Mills equipped with "Techni" Process Rolls you will get increased production and more rolled tons between roll dressings. These profit-making advantages are made possible with "Techni" Process Rolls because they have greater strength, excellent finish, unusual wearing qualities, resistance to slippage and fire cracking.

"Techni" Process was developed exclusively by Mackintosh-Hemphill. It regulates the quality and grain size of the rolls with as much exactness as the best modern steel practice regulates the quality of steel. Now more than ever, Mackintosh-Hemphill and "Techni" Process rolls will assist you to get the most for every roll-dollar you spend.

Since 1803—Pioneers, Engineers and Builders

MACKINTOSH-HEMPHILL COMPANY - - - - Pittsburgh and Midland, Pennsylvania

The Rolls with the Red Wabblers
They Roll More Tons Per Dressing

equip all stands with

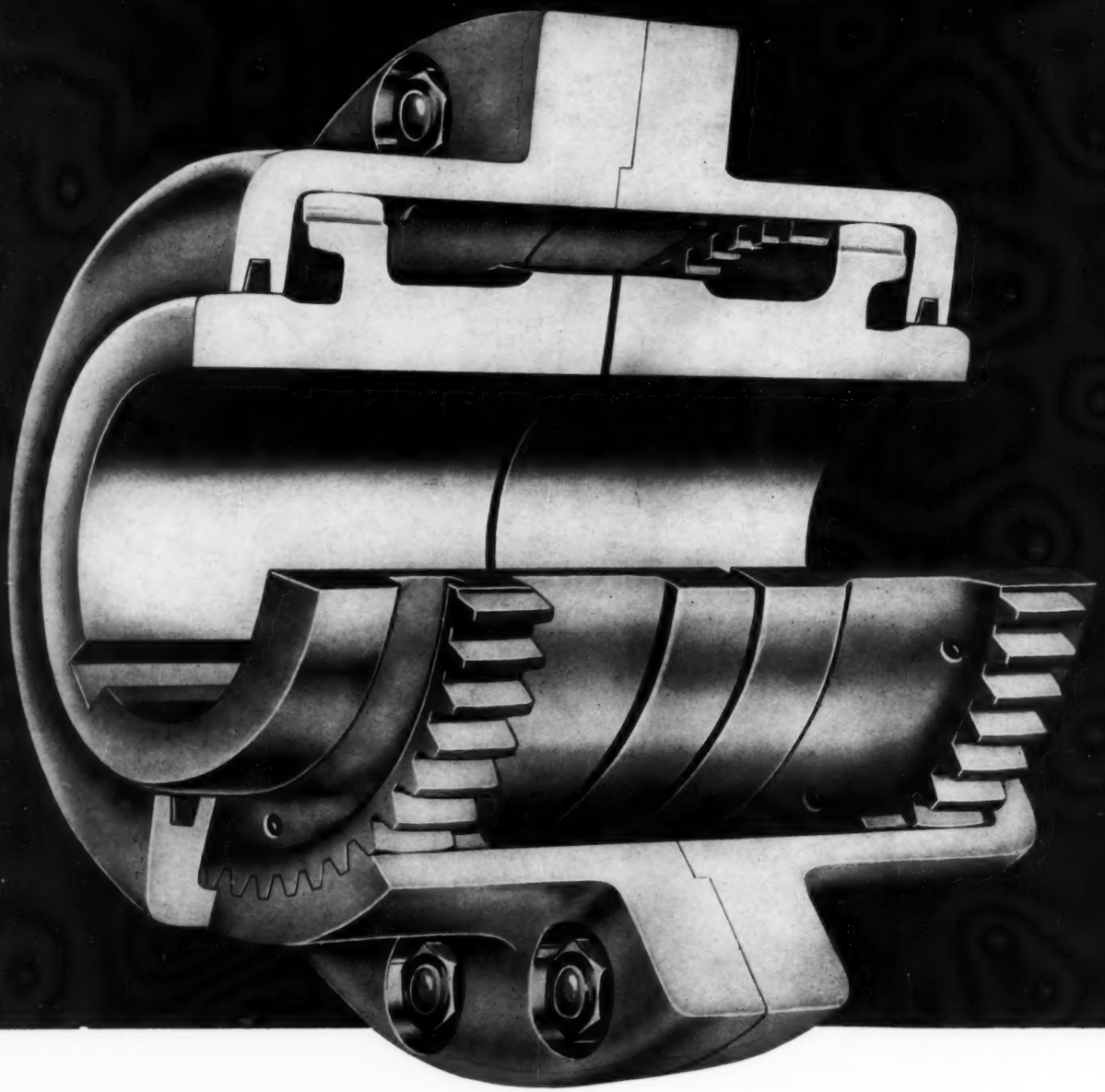
"Techni"

PROCESS IRON AND STEEL BASE ROLLS

OTHER MACKINTOSH-HEMPHILL PRODUCTS:

Rolling Machinery . . . Shape Straighteners . . . Strip Coilers . . . Shears . . . Levellers . . . Pinions . . . Special Equipment . . . Iron-Steel Castings . . . The NEW Abramsen Straightener . . . Improved Johnston Patented Corrugated Cinder Pots and Supports . . . Heavy Duty Engine Lathes

POOLE



A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY WOODBERRY, BALTIMORE, MD.

Two 15-ton-100'-0" span Cleveland *all-welded* steel-mill cranes operating over continuous pickling lines.

WHERE UNINTERRUPTED CRANE SERVICE IS VITAL, PLAY SAFE WITH

CLEVELAND *all-welded* CRANES

In the big mills, on the jobs where crane service is vital, many Cleveland all-weldeds will be found because they can be depended upon to carry through peak loads without interruption.

You, too, will find it profitable to install Clevelands in those places where crane service *must* be available.

THE CLEVELAND CRANE & ENGINEERING CO.

1131 EAST 283RD STREET • WICKLIFFE, OHIO.

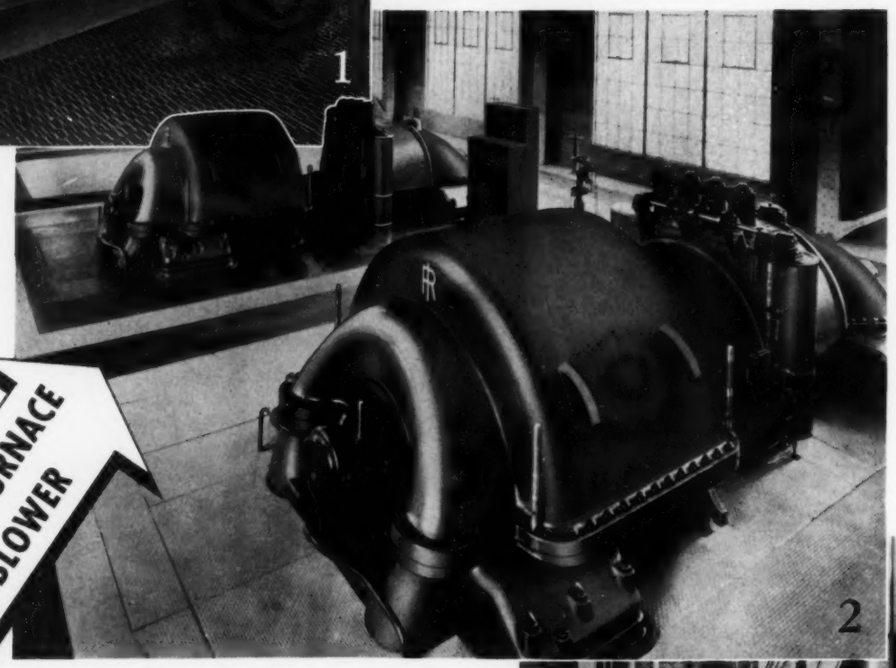
MANUFACTURERS OF • CLEVELAND CRANES • CLEVELAND TRAMRAIL • STEELWELD BENDING PRESSES

CLEVELAND *Steel Mill* CRANES

8 NEW BLOWERS IN THIS MODERN STEEL PLANT

GAS BOOSTER

1



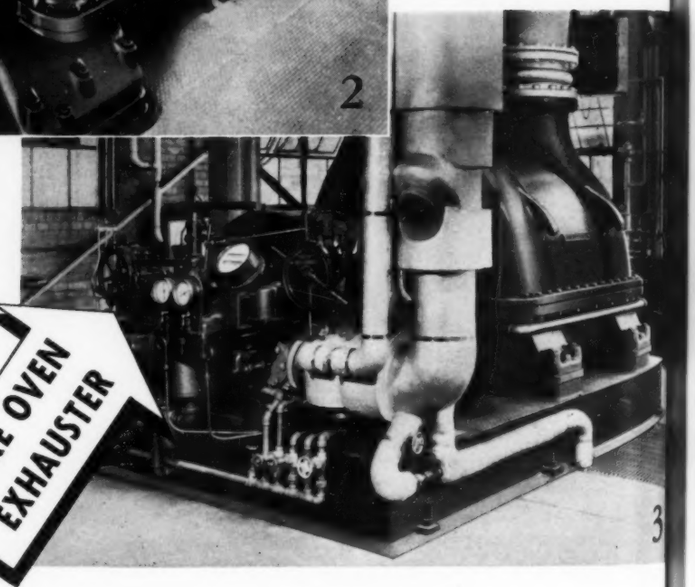
BLAST FURNACE BLOWER

2

1 *The 850-hp gas boosters each handle 27,000 cfm of producer gas.*

2 *Each of these Ingersoll-Rand blast furnace blowers delivers 60,000 cfm at 30 lbs. pressure.*

3 *One of the three multi-stage turbine-driven blast furnace blowers used in exhausting coke ovens.*



COKE OVEN EXHAUSTER

3

The Great Lakes Steel Co., in modernizing its Detroit, Mich. plant, chose 8 Ingersoll-Rand turbo blowers for blast furnaces, coke plant and gas distribution.

Practically every steel producer in the U. S. A. is using Ingersoll-Rand turbo blowers for handling air or gas. Included in the I-R line are blowers from 2 to 14,500 hp. There are turbine-driven blast furnace blowers, motor or turbine-driven gas boosters, coke-oven exhausters, motor-driven combustion-air blowers, and auto-dynamic gas mixers.

There is an experienced I-R representative in every steel center—ask his help in solving your blower problems.

Ingersoll-Rand

11 BROADWAY, NEW YORK CITY

Branches or Distributors in other Principal cities the world over

Atlanta	Cleveland	Hartford	New York	San Francisco
Birmingham	Dallas	Houston	Philadelphia	Scranton
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Buffalo	Detroit	Knoxville	Pittsburgh	St. Louis
Butte	Duluth	Los Angeles	Pottsville	St. Paul
Chicago	El Paso	Newark	Salt Lake City	Tulsa
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Montreal Mexico Havana Rio de Janeiro Caracas Buenos Aires Lima
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12-45

YOUR finished product is your customer's raw material —the first step in mass-production that measures accuracy in *thousandths.*

Morgan Four-Strand Rod Mills are producing rod at four-fifths of a mile per minute *per strand,* within ± .005 inch specified diameter. Uniformity such as this is a Morgan characteristic. It will hold your customers—as it has ours—both now and also *after* the Emergency.

MORGAN
WORCESTER
ENGINEERS AND
MANUFACTURERS

MORGAN CONSTRUCTION COMPANY • WORCESTER, MASSACHUSETTS

R-96

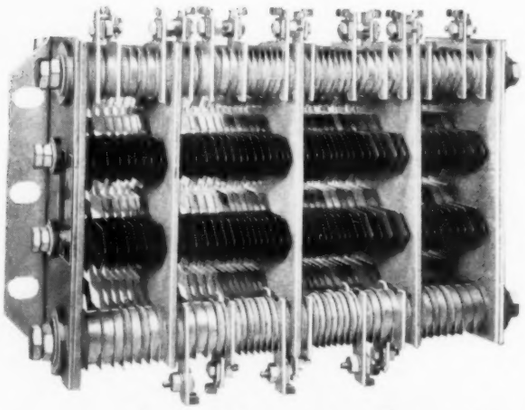
P-G Steel Grid RESISTORS

for Internal Mounting
In LARGE and Small
FACE PLATE CONTROLLERS

Standard units for
5 to 65 H. P. Motors.

Design of the P-G Steel Grid Resistor makes it possible to supply correct ohmic values as well as ample capacity. The ability to meet *both* of these requirements is assurance of accurate control with full protection to motors using either large or small Face Plate Controllers.

All steel construction, mica insulation, provision for expansion, and ample ventilation combine to produce the exceptional stamina called for by today's production schedules.



Standard units for
2 to 25 H. P. Motors.

P-G

"The Resistor you can Install and Forget"

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI, OHIO

"NATIONAL" ROLL

The Invisible Ingredient

The invisible ingredient of NATIONAL ROLLS is *character.*

More than the appearance of smoothness or precision sizing is necessary, as all rolls appear much the same when new, until the inevitable ingredient—character—is attested by endurance.

On such character depends not only the uninterrupted and accurate production of the mill, but the continued service of the shapes on ahead to every part used in later assemblies.

NATIONAL ROLLS accept this responsibility.

W. H. Seaman
President & General Manager

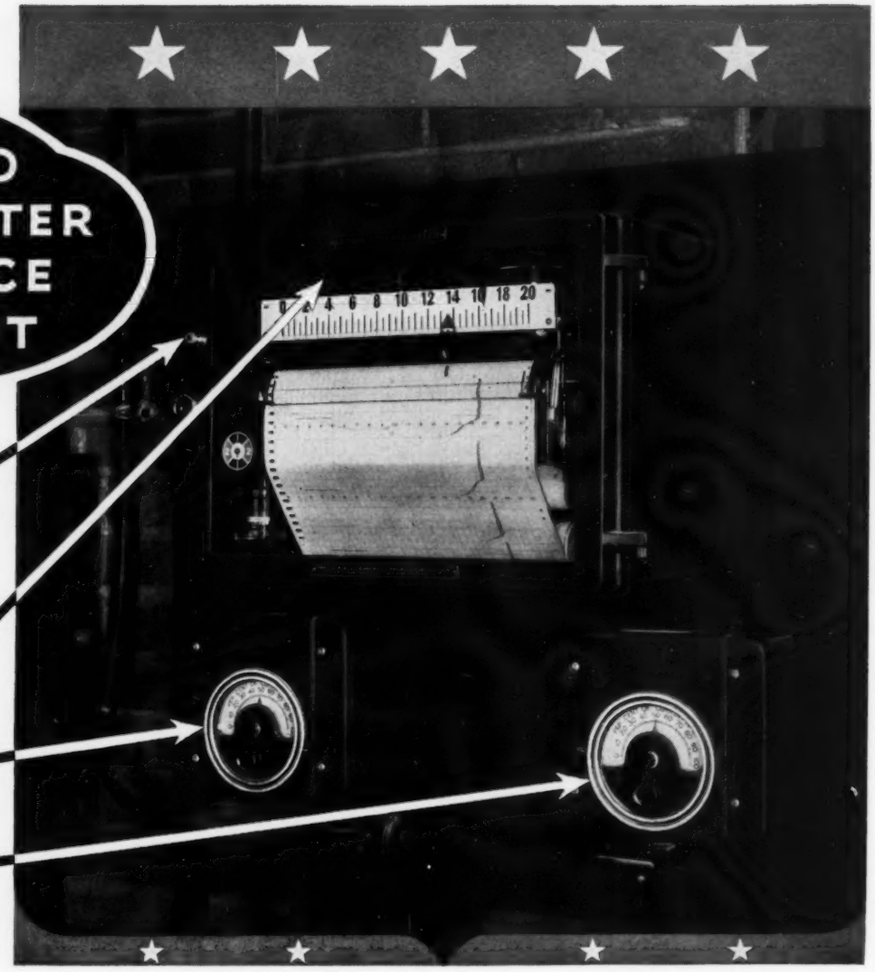
ROLLS
ROLLING MILL MACHINERY

All Types of Iron and Alloy Iron Rolls for Rolling Mill Purposes
FERROUS AND NON-FERROUS

THE NATIONAL ROLL & FOUNDRY CO.

Office and Works: AVONMORE, PA., U. S. A.

HOW TO GET GREATER FURNACE OUTPUT



Set index to desired starting temperature.

Set Soaking Temperature Switch at desired holding temperature.

Set "Rate Control" at desired degrees per hour.

Set "Soaking Time Control" at deisred time in hours and minutes.

Upon completion of program, fuel will be shut off and or signal given.

IN the manufacture of aircraft parts at the Kellett Autogiro Corporation, Philadelphia, *Time and Temperature* are important factors in producing desired results.

The Brown Program Potentiometer Controller, shown above, automatically raises, holds or lowers temperatures according to a predetermined Time-Cycle Control schedule. This is accomplished by a timer mechanism operating a motor-driven control index in the instrument. By virtue of the Timer-Control index combination, program flexibility is almost unlimited. The operator merely sets the dials, as in a radio, and fixed cams, etc., are eliminated.

To the steel treater who appreciates the importance of accurate temperature measurement and positive control of furnace operation, Brown Potentiometer Controllers offer worthwhile advantages. They help to speed up and maintain manufacturing schedules along predetermined lines of increased production, standardized quality and lower costs.

They are designed to work singly or in complete coordination for the control of a single factor or complete control of an entire process. They are supplied for controlling any type of furnace . . . oil, gas or electric. You'll find Brown Instruments everywhere, on all makes of furnaces, used for every kind of work where closely held temperature is essential to "all out" production.

Write for Bulletin 85-17. THE BROWN INSTRUMENT COMPANY, 4464 Wayne Avenue, Philadelphia, Pa. Offices in all principal cities. Amsterdam-C, Holland: Wijdesteeg 4—England: Wadsworth Road, Perivale, Middlesex —Stockholm, Sweden: Nybrokajen 7.

BROWN POTENTIOMETER CONTROLLERS

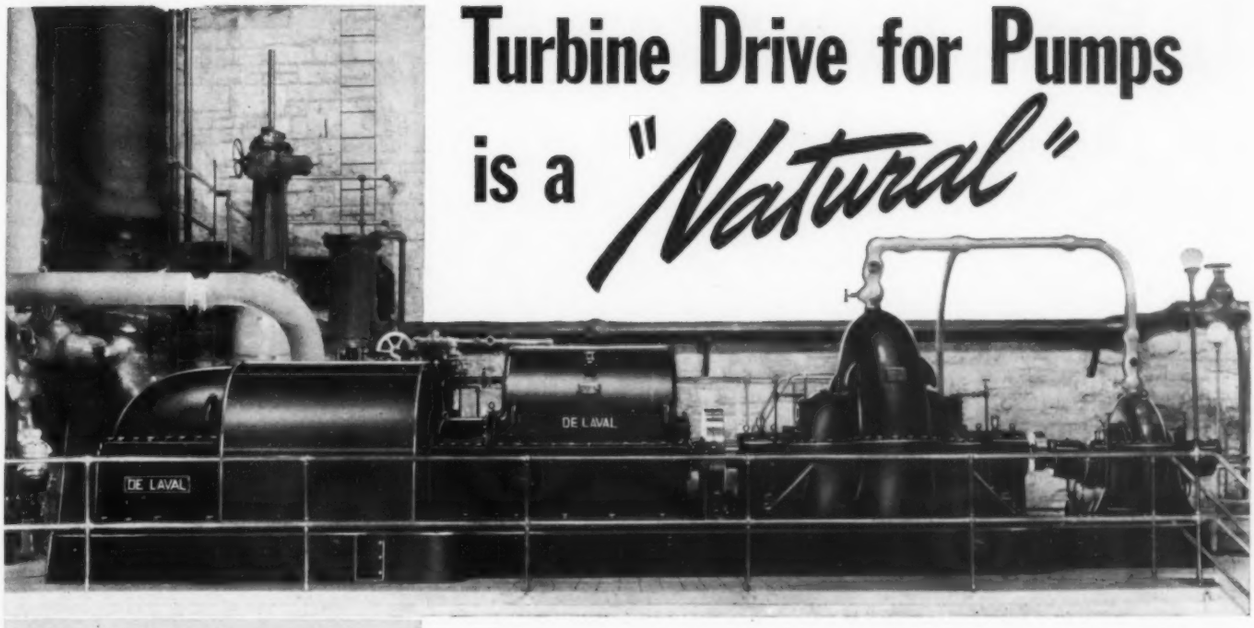
THE BROWN INSTRUMENT COMPANY, PHILADELPHIA, PENNSYLVANIA

DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR CO.

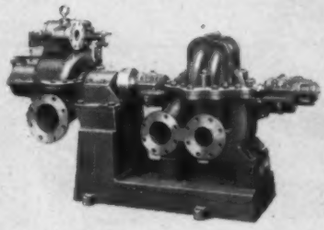
MINNEAPOLIS, MINNESOTA, AND 119 PETER STREET, TORONTO, CANADA

TO MEASURE AND CONTROL IS TO ECONOMIZE

Turbine Drive for Pumps is a "Natural"



Geared pressure-stage turbine driving water works pump; 80 m.g.d. against 187 ft. head, using steam at 175 psi. and 533°F. This unit developed a duty of 222.8 million foot pounds per 1,000 lb. of steam, as corrected to contract conditions.



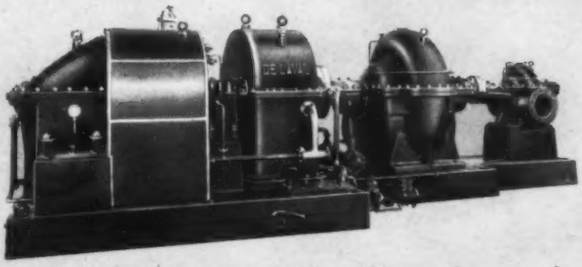
Velocity-stage turbine driving boiler-feed pump; 1,000 g.p.m. against 807 ft. head at 3,500 r.p.m.

THE speed of steam turbine driven pumps can readily be controlled, either automatically or manually, to supply just the desired head and flow, thereby avoiding the great waste of power incurred in throttling motor-driven pumps to meet head and flow requirements.

Large centrifugal pumps driven through speed reducing gears by De Laval multistage condensing turbines develop high duties, and are free from the transmission charges, losses and interruptions of service inseparable from motor drives.

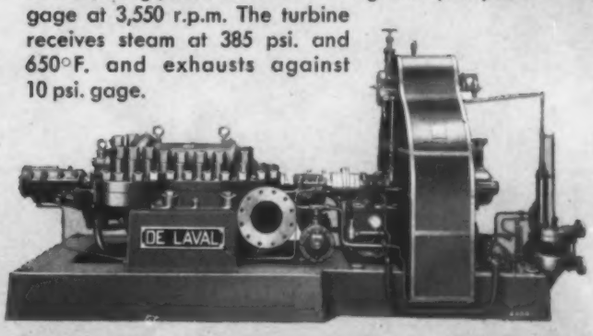
De Laval velocity-staged turbines exhausting to feed heaters or to process show similarly high economies and are most sturdy and reliable drives for power plant or process pumps.

State your conditions and ask for Publication T-3525.



Geared pressure-stage turbine driving main pump of 20,000 g.p.m. capacity against 148 ft. head and condenser circulating pump of 1,300 g.p.m. against 60 ft. head.

Velocity-stage turbine driving six-stage boiler feeder; 850 g.p.m. of 220°F. water against 1,600 psi. gage at 3,550 r.p.m. The turbine receives steam at 385 psi. and 650°F. and exhausts against 10 psi. gage.



DE LAVAL Steam Turbine Co.
TRENTON, N. J.

MANUFACTURERS OF TURBINES — STEAM, HYDRAULIC PUMPS — CENTRIFUGAL, PROPELLER, ROTARY DISPLACEMENT, MOTOR-MOUNTED, MIXED-FLOW, CLOGLESS, SELF-PRIMING CENTRIFUGAL BLOWERS and COMPRESSORS, GEARS — WORM, HELICAL and FLEXIBLE COUPLINGS

It Pays To SPECIFY FLAME-PRIMING
on New Equipment and Structural Steel

because it prepares steel for better, faster, longer-lasting paint jobs . . .

OXY-ACETYLENE flame-priming of steel to remove loose scale, rust, and moisture before painting can, in many cases, completely eliminate sand-blasting. At the same time, this process does away with the necessity for chemical treatment of the steel prior to painting.

Flame-priming can be applied to structures of practically any size. Irregularity of shape, recesses, rivets, or other "hard-to-get-at" parts offer no obstacle. This process is easy to learn, easy to use, and requires only a small amount of equipment.

Shown above is an operator using an Oxweld flame-priming blowpipe to prepare a large tank for a perfect paint job. The acetylene is from three manifolded Prest-O-Lite cylinders.

How It Works—To use flame-priming, a heating head is passed quite rapidly over the surface to be cleaned. The quick surface heat causes the loose scale to break away, and at the same time drives out surface moisture. The priming operation is closely followed by wire-brushing, and the paint is then applied while the metal is still warm and dry. As a result, the paint flows on faster, bonds tighter, and dries quicker. And because loose scale, rust, and surface moisture have been eliminated, subsequent paint flaking is avoided.

and Linde can help you use it!

If you would like to know more about flame-priming, get in touch with Linde! Whether it's welding, cutting, flame-hardening, flame-softening, descaling, or hard-facing—if it is a "flame" process—*it pays to ask Linde!*

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

General Office: New York, N. Y. UCC Offices in Principal Cities
In Canada: Dominion Oxygen Company, Limited, Toronto

ENR-7

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THE LINDE AIR PRODUCTS COMPANY
30 East 42nd Street — Room 308
New York, N. Y.

Without obligation, please send me the reprint "Flame-Priming Process"

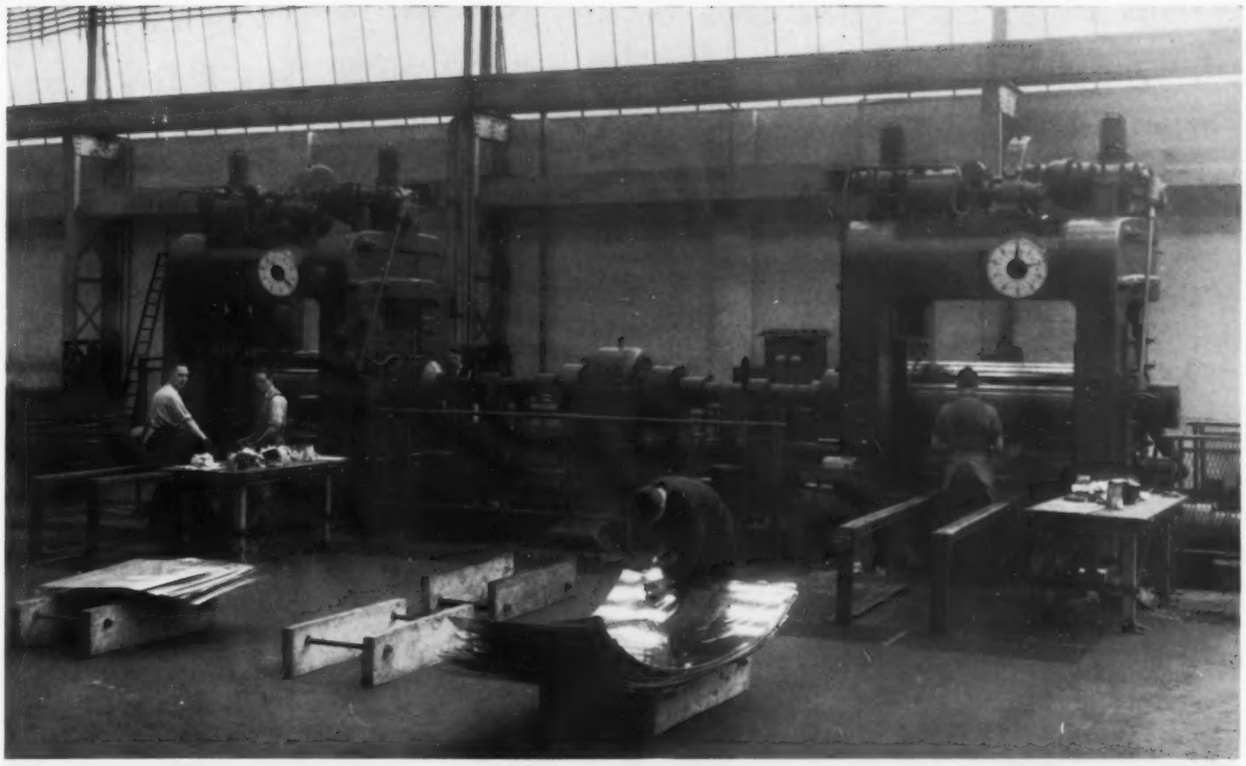
*Name*_____

*Street and No.*_____

*City and State*_____

LINDE OXYGEN . . . PREST-O-LITE ACETYLENE . . . UNION CARBIDE
OXWELD, PUROX, PREST-O-WELD APPARATUS . . . OXWELD SUPPLIES

The words "Linde," "Prest-O-Lite," "Union," "Oxweld," "Purox," and "Prest-O-Weld" are trade-marks of Units of Union Carbide and Carbon Corporation.



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WORLD WIDE EXPERIENCE

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OUR DESIGNS COMPRISE THE

MOST MODERN FEATURES WHICH ASSURE

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RELIABILITY

BEST QUALITY AT LOW COST

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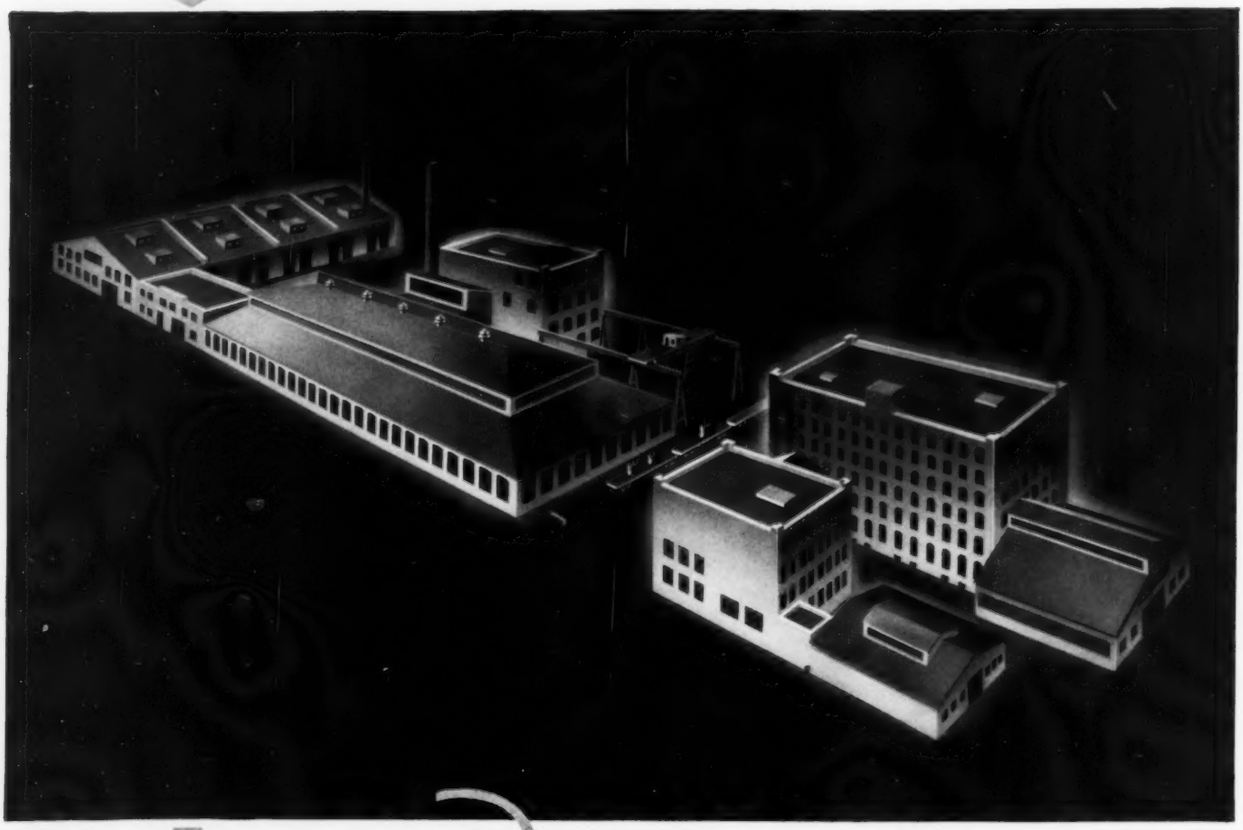
WAR FINDS US READY

We are building the transformers war industries require . . . and we're going to continue doing so *faster* and *better* than ever before!

We have trained our personnel for this very emergency! We have greatly enlarged our plant facilities! We have installed the most modern equipment for manufacture and testing. We promise experience and skill in research, engineering and workmanship.

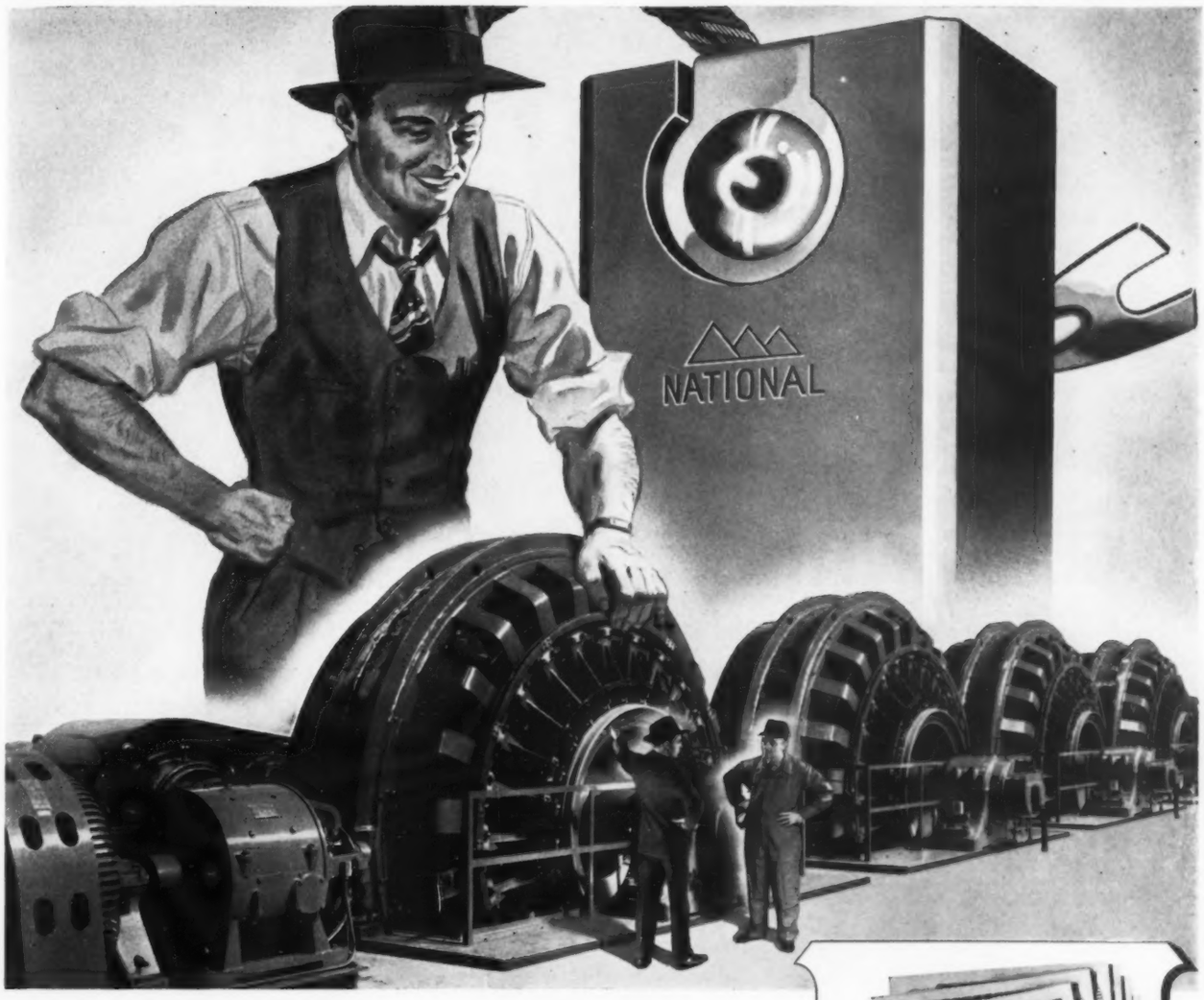
These are Pennsylvania's facilities . . . geared for *immediate action.* They are yours to command!



Pennsylvania

TRANSFORMER COMPANY

808 RIDGE AVENUE, • N. S., PITTSBURGH, PA.



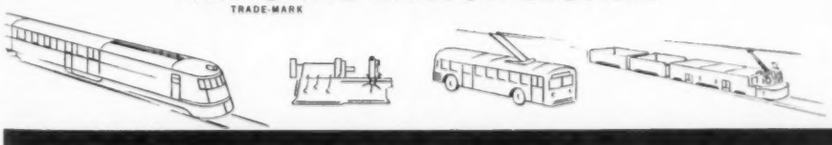
KEEP THEM RUNNING

DEPENDABLE POWER IS ESSENTIAL IN THE PRESENT EMERGENCY

● Assure yourself of dependable brush performance on your electrical equipment by enlisting the aid of your National Carbon sales representative. He is capable of giving you valuable assistance in the selection and application of brushes on your generators and motors.

As further assurance of maximum reliability and economy of operation, the services of our engineering staff, experienced in the solution of difficult operating problems, are yours at no added cost when you specify . . . .

NATIONAL CARBON BRUSHES
TRADE-MARK



MODERN PYRAMIDS
Another NATIONAL Service

These bulletins contain practical information on brushes and commutation of especial value to operating and maintenance men. If you are not receiving them, send us your name and address.

NATIONAL CARBON COMPANY, INC.
Unit of Union Carbide and Carbon Corporation
Carbon Sales Division: Cleveland, Ohio • • General Offices: 30 E. 42nd St., New York
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GET IT WITH SPEER MOTOR AND GENERATOR BRUSHES

Motors and generators can be kept at top efficiency only with good commutation. Let SPEER Engineers bring you the benefits of SPEER'S more than forty years of study and research in commutation engineering. Start now by sending for SPEER Data Forms—one for each machine you want to improve. This will make it easy for you to state the facts on which we can base competent recommendations.

FAMOUS AMERICAN FIRSTS

THE INCANDESCENT LAMP 1879
SPEER BRUSHES
To meet the requirements of most industrial motors, SPEER Electro-Graphitic Brush grades E-23 and E-24. Also available is Multiflex Brushes. Write today for complete descriptive catalog.
There is one right brush grade for every job —and SPEER makes it.
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SPEER MOTOR AND GENERATOR BRUSHES

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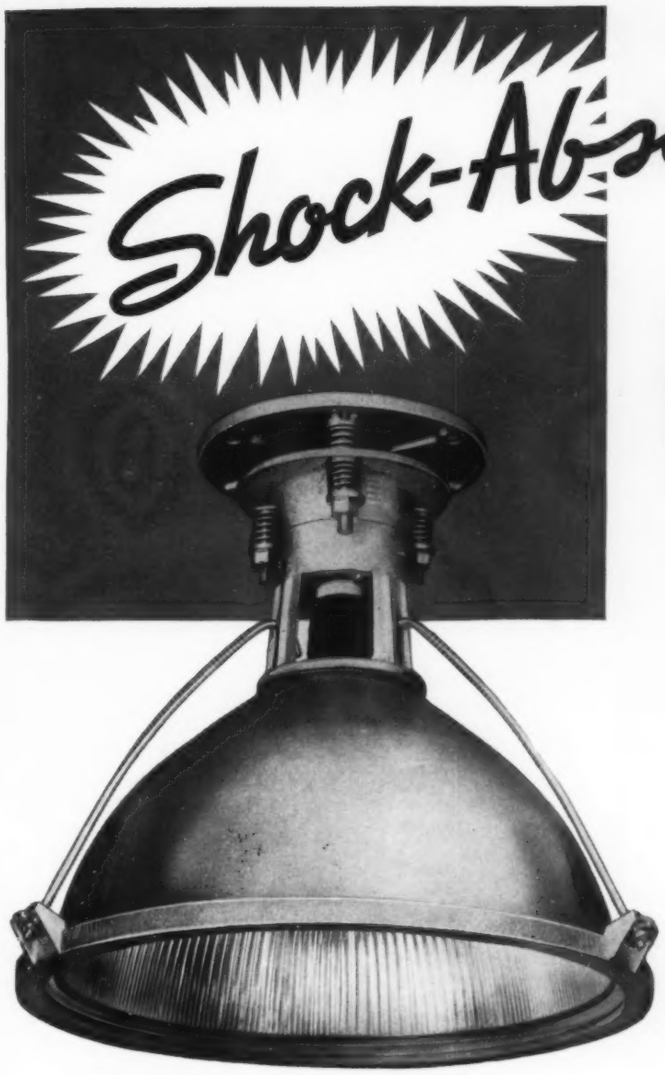


HOLOPHANE CRANELITE

DEFIES VIBRATION AND DESTRUCTIVE "WHIP"

●

Special Construction Features

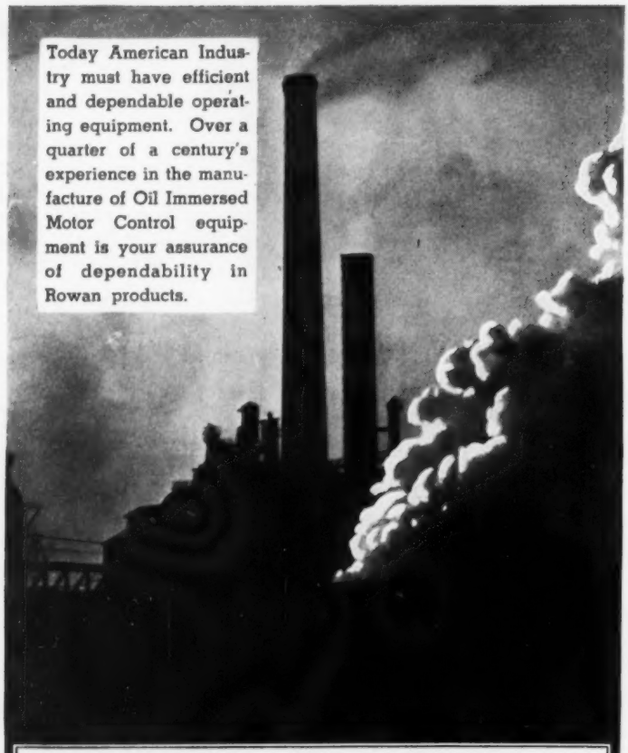
- **WIDE FLANGE**
  10¼" steel plate maintains solid contact with crane
- **STEEL SPRINGS**
  Double action springs absorb shocks up and down, and in a lateral direction
- **EASY RELAMPING**
  is possible because of its position on catwalk
- **LIGHT UNDER CRANE**
  Ideal illumination for area directly below crane

For years steel mill engineers have sought, for use under cranes, a lighting unit that would endure despite the most trying conditions of vibration and whip. Holophane Cranelite No. 694 is that unit. It uses lamps from 500 to 1500 watts. It provides highly efficient illumination directly below the crane—safely, enduringly, and economically.

WRITE FOR FULL DETAILS AND ENGINEERING SPECIFICATIONS ON *CRANELITE NO. 694

Holophane
COMPANY, INC.
Lighting Authorities—Since 1898
342 MADISON AVE.
NEW YORK CITY
THE HOLOPHANE CO. LTD.
385 Yonge St., Toronto, Canada

(*Product of Holophane Research)


Today American Industry must have efficient and dependable operating equipment. Over a quarter of a century's experience in the manufacture of Oil Immersed Motor Control equipment is your assurance of dependability in Rowan products.

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THE ROWAN CONTROLLER CO., BALTIMORE, MD.

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MOTOR CONTROL

BY USERS EVERYWHERE

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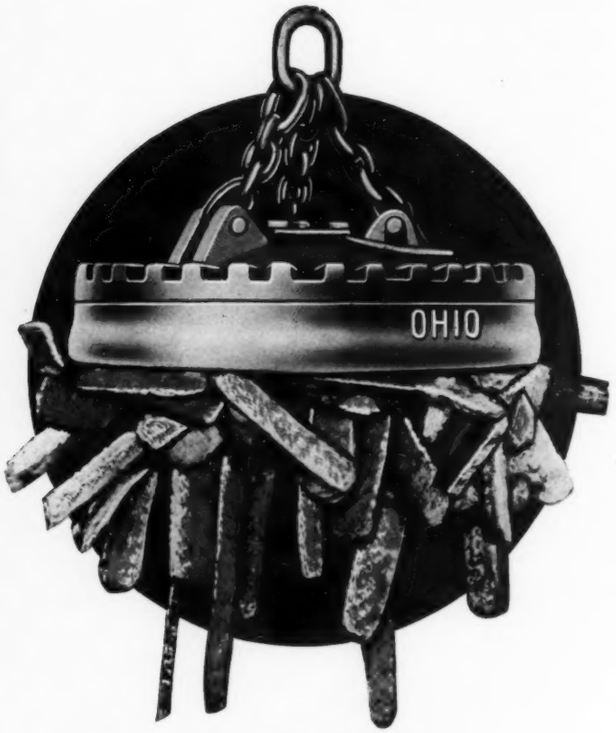
OHIO
Maximum Lift MAGNETS



A standard 65″ Ohio Magnet Lifting 5200 lbs. of Pig Iron

Standard round general purpose Ohio magnets are built in sizes from 12″ to 65″ in diameter.

Average lifting capacity for pig iron or scrap ranges from 200 lbs. to 6200 lbs.

Depending upon the amount of material to be handled, the largest suitable magnet will do it most economically.

Labor cost per lift is the same whether the lift be 200 lbs. or 6200 lbs.

OHIO reliable MAGNETS

THE OHIO ELECTRIC MFG. COMPANY

5907 Maurice Ave. Cleveland, Ohio

Dripping, Leaking Oil

Kept Off Steel

You'll save time spent in cleaning steel and you'll save money on the cost of lubricant, by using drip-less, waste-less NON-FLUID OIL.

There'll be no oil showers from overhead bearings for NON-FLUID OIL stays where applied until used up. You get dependable lubrication at less cost per month, because NON-FLUID OIL outlasts oil 3 to 5 times.

Used successfully in leading iron and steel mills. Send for testing sample today—prepaid —NO CHARGE.

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Main Office: 292 Madison Ave., New York, N. Y.

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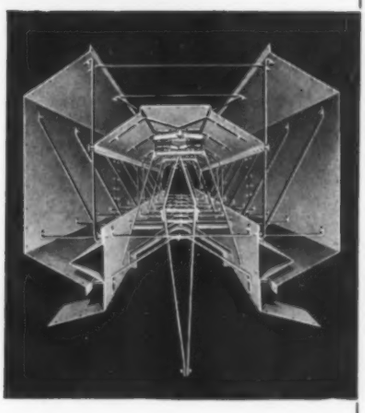
TRADE MARK REGISTERED
NON-FLUID OIL
IN U.S. PAT OFFICE & FOREIGN COUNTRIES

MODERN STEEL MILL LUBRICANT

Better Lubrication at Less Cost per Month

Cutaway View

Sectional View



BURT MONOVENT

Continuous Ridge

VENTILATOR

Helps Keep Workers on the Job

Adequate ventilation of your steel mill is a prime essential for the efficiency and health of your workers. Monovent is particularly designed to move large volumes of hot or fume-laden air from areas extending the length of a machine or of the whole building. As Monovent utilizes the entire ridge or apex of the building, it affords extraordinary capacity and uniformity of exhaust air flow.

Other advantages presented by Monovent are . . . Low cost, less than for unit ventilators . . . Fine appearance . . . Takes fullest advantage of wind action . . . Storm proof—no back drafts . . . Will not clog with soot or cinders. No moving parts to get out of order.

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ROOF VENTILATORS • OIL FILTERS
EXHAUST HEADS
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SEND FOR CATALOGS
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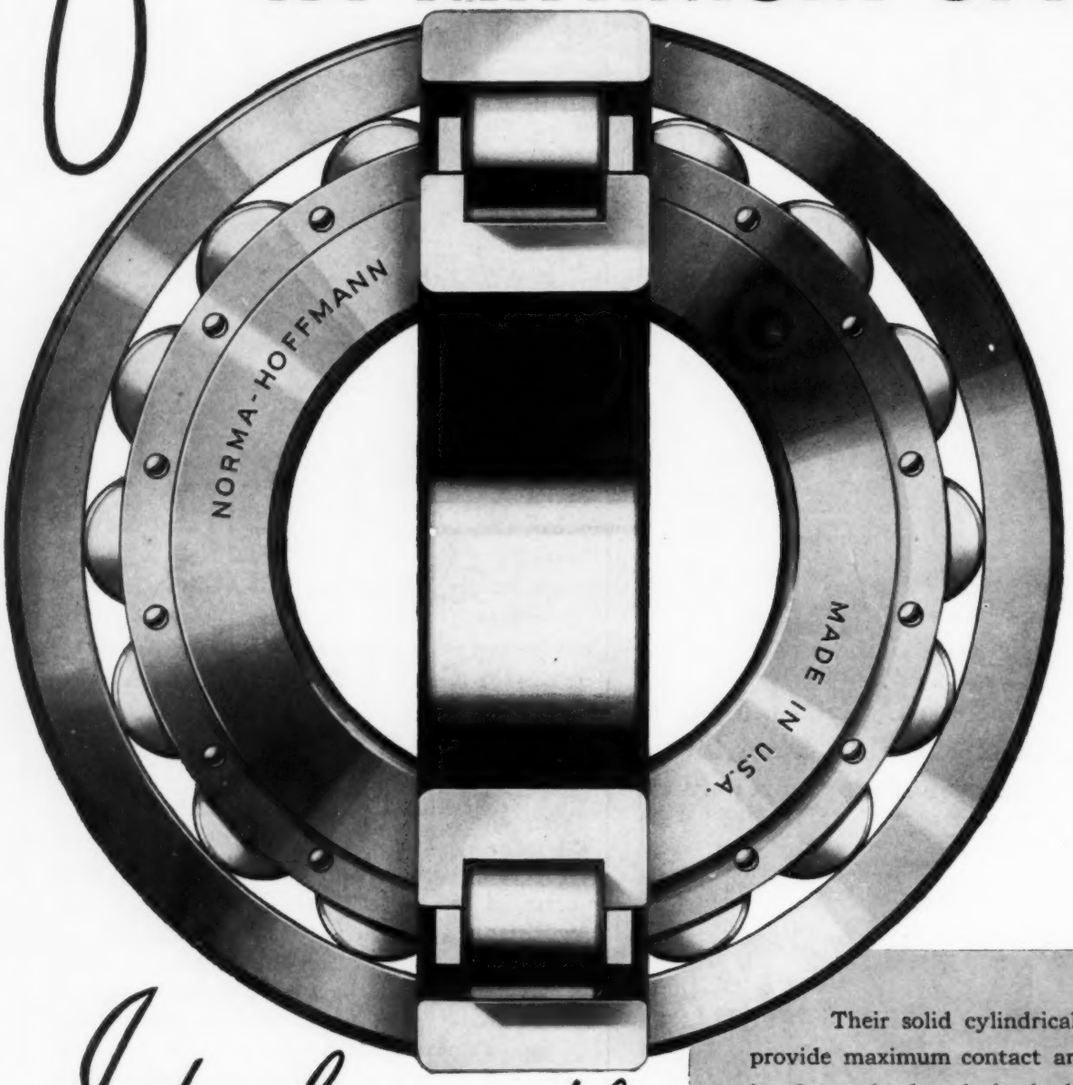
Burt Engineers are glad to help on plans

for MAXIMUM CAPACITY IN MINIMUM SPACE



Interchangeable

WITH SINGLE-ROW BALL BEARINGS

NORMA-HOFFMANN

PRECISION ROLLER BEARINGS

NORMA-HOFFMANN BEARINGS CORP'N.,

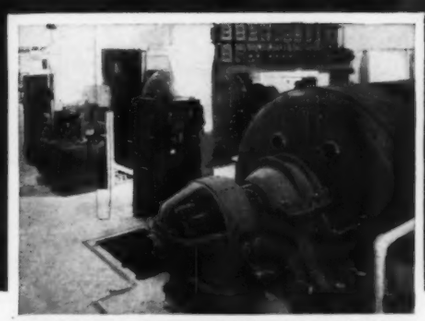
STAMFORD, CONN., U. S. A. • *Founded in 1911.*

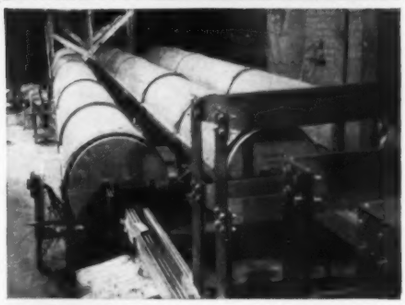
Write for the Catalog. Let our engineers work with you.

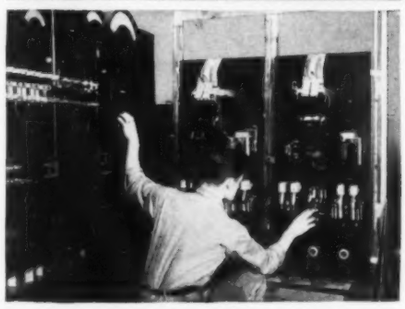
Their solid cylindrical rollers provide maximum contact area, giving larger load and shock-absorbing capacity than any other single-row bearing of like dimensions. Thus, when NORMA-HOFFMANN PRECISION ROLLER BEARINGS are used in place of ball bearings, a greater factor of safety is provided, together with added life, particularly under vibration and overload. PRECISION qualities in workmanship and materials adapt them alike for both low and high speeds.

I-T-E Looks Ahead

We keep on Searching... Trying... Testing...







The main illustration—making an oscillogram. Top of three—a part of the I-T-E high-current laboratory; middle—a heat test of a metal-clad bus; bottom—typical calibration of circuit breakers.

War makes no change in the responsibilities of the I-T-E laboratory staff. The duties of engineers engaged in design of switchgear or in routine tests of completed structures have always been, and always will be, vital. This war only puts new emphasis on normal research and testing functions.

Under the conditions of war, no one needs to point out the value of switchgear which, by perfect action, enables industry to avoid needless stoppages when electrical disturbances occur. It is from research that we acquire dependable, time-saving guides at the start of design. It is from testing that we gain the certainty of performance in service. Both research and testing have the additional value of enabling I-T-E to devise new equipment in anticipation of coming needs.

I-T-E

AIR SWITCHGEAR

IMMERSED IN AIR • ENCASED IN STEEL

I-T-E

Representatives in Principal Cities

CIRCUIT BREAKER CO., PHILADELPHIA, PA.

Typical COMMUTATOR of the NEW G-E D-C MOTOR

WE ASSEMBLE IT WITH 12 TONS PRESSURE

Assembly parts of the new G-E direct-current motor commutator: quill, steel caps, mica cones, hardened-copper and mica segments, and retaining lock nut

BUT YOU CAN TAKE IT APART —AND PUT IT TOGETHER— WITH A HAND WRENCH

YOU get good commutation in a G-E direct current motor because the great pressure and high temperature applied in assembling the commutator—plus careful machining — assure rigidity, uniformity, and precise alignment of every part. Yet, in an emergency, the entire commutator can be conveniently disassembled after removing a steel lock nut and set screw. Reassembling on the job requires no press.

You'll find other new features in this commutator: mica segments on the open end extend beyond the copper segments to give increased creepage paths; a tumbling process completely eliminates burrs from the hard-drawn copper segments; and the end of the assembly has a smooth, arc-resistant surface of Glyptal No. 1201 Red.

But features of the General Electric d-c motor are by no means limited to the commutator. Get the facts on the tough armature; sturdy, adjustable brush rigging; Formex wire field coils; and improved bearings. Call or write your local G-E office for details that show why you can expect economical, dependable service from this motor. General Electric, Schenectady, N. Y.

General Electric d-c motor, Type B, typical of the smaller ratings

GENERAL ELECTRIC